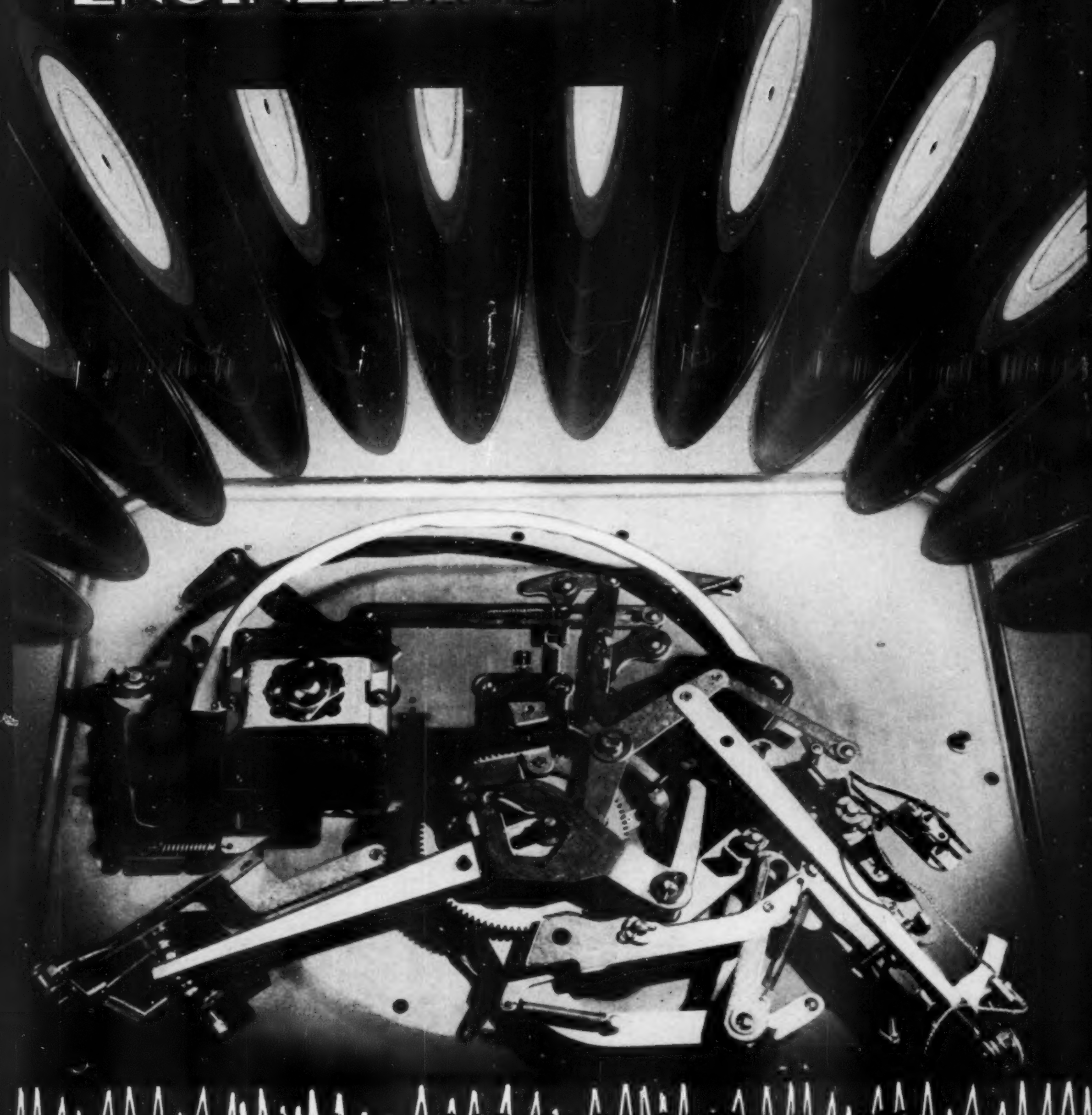
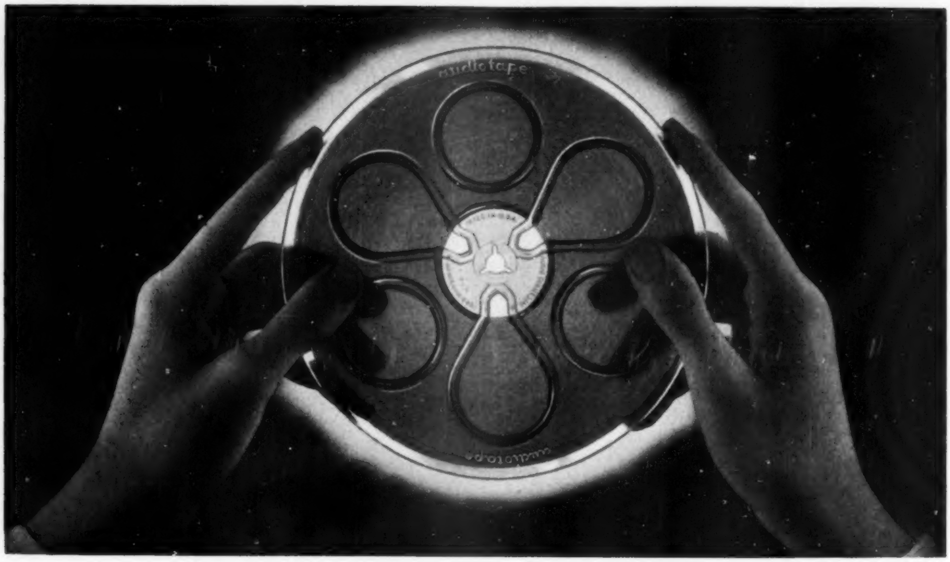
AUDIO ENGINEERING

SEPTEMBER
1951
35c



You don't have to look, because
THERE ARE NO SPLICES
in audiotape*



... but this "transparency test" shows some other important things about Audiotape quality

■ When you hold a reel of plastic base Audiotape up to the light, notice its extremely uniform translucency—free from dark rings or fuzzy areas. You can see your fingers right through it, sharply outlined against the light. This is proof of the clean, straight line slitting that makes Audiotape track and wind absolutely flat. There are no rough or turned-over edges which would lift the tape away from the heads, causing loss of high-frequency response. Of course this test also proves that the tape is entirely free from splices. But with Audiotape you can be sure of that without looking. For all 1250 foot and 2500 foot reels of plastic base Audiotape are *guaranteed splice-free!*

You can *see* the output uniformity of Audiotape, too. For every 5-reel package includes an Esterline-Angus output chart, showing the measured output of the entire length of one of the reels in the package. And since all 5 reels are slit from the same roll after coating, the chart actually measures the uniformity of all the tape in the package. This gives positive visual proof of Audiotape's unequalled output uniformity.

NO OTHER TAPE OFFERS YOU ALL OF THESE EXTRA-VALUE FEATURES:

■ **Splice-Free Reels.** All 1250 and 2500 foot reels of plastic base Audiotape are *guaranteed* to be free from splices.

■ **Unequalled Uniformity.** Plastic base Audiotape is guaranteed not to exceed ±¼db within the reel and ±½db from reel to reel.

■ **Output Curves** in every 5-reel package of plastic base Audiotape show actual measured output of the tape contained in the package.

■ **Maximum Output with Minimum Distortion.** Oxide formulated to give high output at bias which results in low harmonic distortion.

■ **Safe-Handling Package** for 2500 and 5000 foot reels permits loading onto turntable without danger of spilling tape from hub, simplifies attachment of reel flanges, and provides safe storage without flattening bottom of roll.

*Trade Mark

AUDIO DEVICES, Inc.

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Successor to RADIO

AUDIO ENGINEERING

Established 1917

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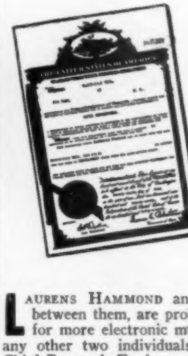
SEPTEMBER, 1951 Vol. 35, No. 9

COVER

The title of this month's cover illustration might well be *Dream of a Music Lover After Seeing a Flying Saucer.* The recordings are arranged to spotlight the many precision parts that make up the business end of the new Garrard RC-80 record changer.

RADIO MAGAZINES, INC., 342 MADISON AVE., NEW YORK 17, N. Y.

AUDIO ENGINEERING (title registered U. S. Pat. Off.) is published monthly at 10 McGovern Ave., Lancaster, Pa., by Radio Magazines, Inc., D. S. Potts, President; Henry A. Schober, Secretary-Treasurer. Executive and Editorial Offices: 342 Madison Avenue, New York 17, N. Y. Subscription rates—United States, U. S. Possessions and Canada, $3.00 for 1 year, $5.00 for 2 years; elsewhere $4.00 per year. Single copies 35c. Printed in U. S. A. Entered as Second Class Matter February 9, 1950 at the Post Office, Lancaster, Pa. under the Act of March 3, 1879.



AUDIO PATENTS

RICHARD H. DORF*

Laurens Hammond and John Hanert, between them, are probably responsible for more electronic music patents than any other two individuals. Hanert is the Chief Research Engineer of the Hammond Instrument Company which, headed by Laurens Hammond, is responsible for the Hammond Organ, the Solovox, and the Novachord of fond memory.

A Hanert patent, No. 2,514,490, brings to full development an idea which this writer had been carrying in the back of his head (too bad it wasn't nearer the front!) for some time—an electronic musical instrument to be played by anyone who can hum a tune, even though he may not know one key from another. It is a monophonic instrument which transforms the most inept humming (as long as it is fairly well in tune) into clean, on-pitch sounds resembling trumpets, woodwinds, and others, complete with pleasant vibrato.

Briefly, the instrument uses the humming (or whistling) to key the output and to control the pitch of the oscillations which are generated electronically. The schematic diagram of *Fig.* 1 shows all the circuitry.

The "player" hums or whistles into one of two microphones, selectable with switch Sw_1. The first is an ordinary one, suitable for whistlers. The second is a crystal mounted at the other end of a rubber tube. A glass tube serves as mouthpiece, with a flexible diaphragm closing it to prevent accumulation of saliva inside. The sounds are amplified by a stage which has a drooping frequency characteristic, as shown by the curve. Its purpose is to emphasize the fundamentals and attenuate the harmonics.

The amplifier output, taken through

[*Continued on page 4*]

* *Audio Consultant, 255 West 84th Street, New York 24, N. Y.*

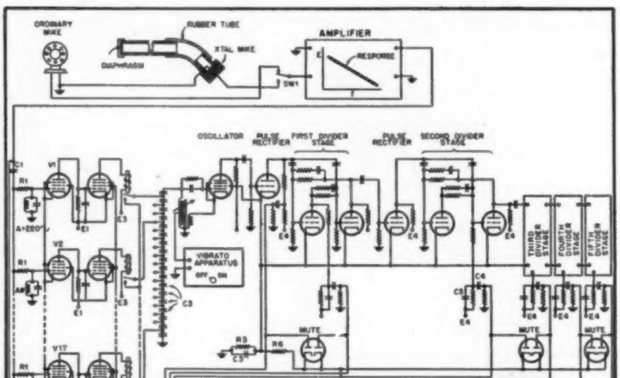


Fig. 1

blocking capacitor C_1, is fed across 18 parallel-tuned circuits with an R_1 isolating each from the others. (Four of the tanks are shown.) Each tank feeds the grid of a tube V_1 through V_{18}, and each tank is tuned to a different semitone of the scale between A-220 cps and D-587.3 cps. The cathodes of the tubes are biased by R_2, and C_2 is the cathode-bias bypass. Each of V_1 through V_{18} is direct-coupled to a following tube, in whose plate circuit is a sensitive relay.

As the "player" hums a note into his microphone, the tank circuit whose pitch the humming corresponds to creates a resonant rise of voltage and energizes the grid of its tube. This makes more plate current flow in the tube and increases the current flow through R_2, which has a rather high value, enough to increase the bias on the other tubes and make them less sensitive. In this way, only one tube is energized at a time. The relay tube following it is also energized and the relay closes.

The relay contacts control the tuning of a variable-frequency oscillator in much the same way as in the older version of the Solovox, which the latter parts of this instrument closely resemble. The capacitive portion of the tank circuit of the oscillator is divided into 18 series capacitors C_3. In

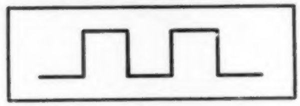


Fig. 2

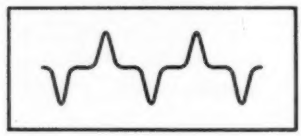


Fig. 3

the normal condition, with no relays closed, the net capacitance value is that of all the capacitors in series, which means minimum capacitance; so the oscillator frequency is at maximum. When one of the relays closes, it shorts the string to ground at some point, increasing the net capacitance value and reducing oscillator frequency. In practice, the pitch obtained is equal to the note the "player" is humming or whistling, but several octaves above it.

The oscillator output is fed through a pulse rectifier which transforms the sine waves into unidirectional pulses and feeds them to the first frequency divider. This is a modified flip-flop circuit, which produces square waves at a frequency one octave below the oscillator. From there the signal goes through additional pulse rectifiers, to second, third, fourth, and fifth frequency dividers, producing the original note in six different octaves. All the cathodes of the frequency-divider and pulse-rectifier tubes are connected together and through R_3 and C_3 to ground for bias.

An output is taken from each frequency-divider plate circuit and fed to a series of stop tablets. The output circuit of each divider includes capacitors C_4 and C_5. C_4, in series, attenuates lows, while C_5, in parallel, attenuates highs. As a result, the output waveform appears, not like the normal square wave the divider generates (*Fig.* 2), but like *Fig.* 3. A square wave contains too much fundamental and is too complex; the waveshape of *Fig.* 3 is better music.

Across each output is one section of a

[*Continued on page 47*]

Hollywood Letter

C. A. HISSERICH*

TWO PIECES of audio equipment recently demonstrated are possessed of extraordinary characteristics. These units were developed for the purpose of providing a measuring standard which would deliver 60 watts of power at less than 0.1 per cent total harmonic distortion in the audio frequency band from 20 to 20,000 cps.

This equipment has been under development for the last five years in the laboratory of Mr. Dunford Kelly of Los Angeles. It consists of a power amplifier and an audio-frequency oscillator. It is not in the scope of this letter to give a detailed technical description of this equipment but rather to report on the interesting aspects of the demonstration. It is hoped that detailed descriptions will be provided by Mr. Kelly in a later article.

The oscillator, mounted on a 7-in. relay rack panel, contains five vacuum tubes *in the oscillator circuit*, has three feedback loops (one of which is positive), and delivers 25 volts to a 600-ohm line. The measured distortion of the waveform over the pass-band is at all times under .001 per cent total harmonic content, the major component being .0006 per cent third. These figures were obtained on a General Radio Wave Analyzer. The output of the oscillator proper is adjusted to have zero source impedance, this output being built out by means of a precision 600-ohm resistor to match the output attenuator. The output attenuator covers a range of 100 db by means of a 10-db-per-step pot and a continuous slide-wire pot which has a 10-db range. The actual oscillator circuit is a modification of the well known phase-shift circuit with additional circuitry added to achieve complete correction for tube capacitances, wiring residuals, etc.

The power amplifier, mounted on a 14-in. panel, delivers full 60-watt output with an input of 1.0 volts across 600 ohms. The output stage consists of a pair of 6BG6's operated at 500 volts plate and 300 volts screen. The output transformer is a slightly massive (!) affair designed by Mr. Kelly, and is unique in that special feedback windings were incorporated to provide *only* those corrections which were required, as determined by preliminary measurements. At a 60-watt output the major distortion component as measured on the wave analyzer occurred at 5500 cps and was .011 per cent second harmonic. The amplifier contains a total of five feed-back loops (two of which are positive), and the loop gain around the major feedback path is flat to 3 megacycles. Mr. Kelly has provided a potentiometer so arranged that the feedback may be adjusted to provide zero output impedance. Under these conditions, the amplifier simulates a constant-voltage generator and the output voltage does not change when the load is removed or reconnected.

The writer was particularly impressed by the thoroughness and care exercised in the application of feedback in these instruments; apparently no "conditional stability"

*954 Hancock Ave., Los Angeles 46, California.

problems exist, and a thorough understanding of Mr. Nyquist's criteria about the 0, −1, point is evident. In demonstrating the effect of feedback in this amplifier, one feedback control was increased to twice the value required to obtain minimum distortion, at which point the output impedance of the amplifier simulated a negative resistance. Even under this condition, no tendency toward oscillation was noted either with the load connected or disconnected.

Mr. Kelly also demonstrated the over-all efficiency of the amplifier to be very high; with no signal, the "coasting" power input to the amplifier is 75 watts, this figure approaching the ratio of 1/1 for standby power versus output power. At full power output of course, the line power requirement increases to approximately 175 watts on signal peaks.

Several unique problems encountered during the development of this equipment were discussed during the demonstration. When working towards low readings of harmonic content, the problem of input noise becomes predominantly important. The input tube finally selected for this equipment was the 6AB4, primarily because of freedom from microphonics and emission irregularities. Another problem brought out in the discussion, was the trouble encountered with capacitor due to a "hysteresis" effect. Normally such an effect would not be noted because of other masking distortions, but in attempting to clean up the residual distortion in this equipment a definite change in distortion readings was noted when a high-grade metal-cased, oil-filled capacitor was substituted for a standard commercial grade unit. Input resistors were also a problem from a noise standpoint, and the best found for this application were the "metallic film" type. Trouble was also encountered with microphonics in the tungsten control lamp used in the oscillator; this was finally cured by constructing a new lamp with adequate filament supports.

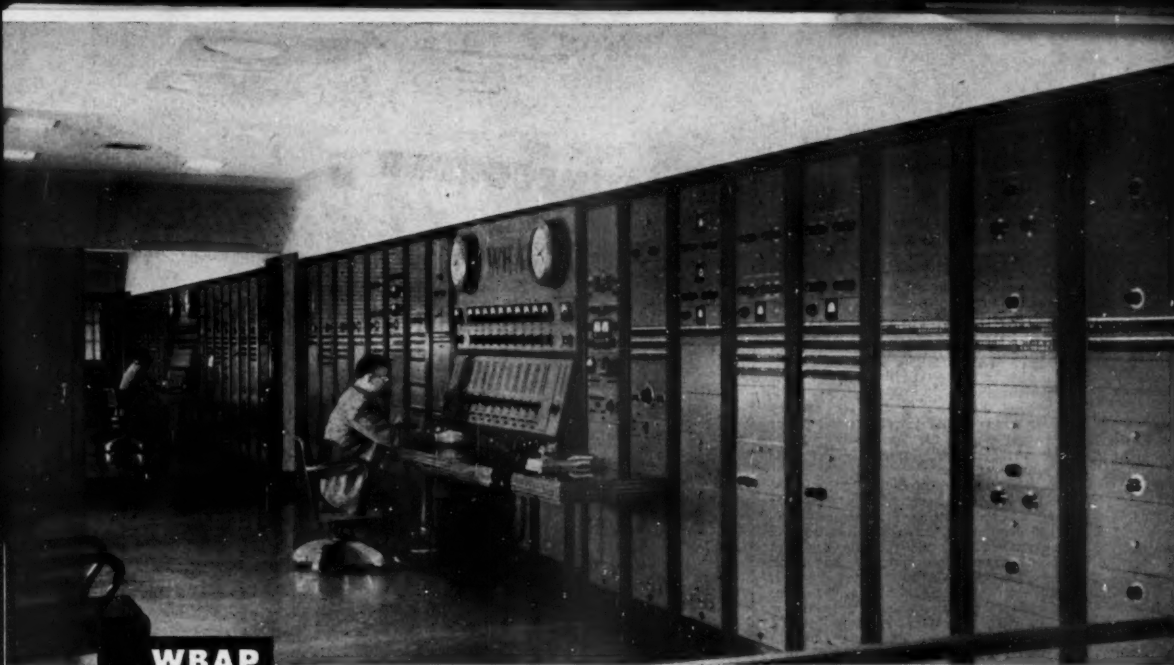
One may well ask, after viewing such a demonstration, "why?" The answer must certainly be that this equipment is definitely "laboratory" measuring equipment, and that its prime function is to enable measurements to be made without "measuring equipment correction." It was pointed out during the discussion following this demonstration that a measurement of 0.5 per cent harmonic distortion in an amplifier driven by an oscillator containing 0.3 per cent distortion does not necessarily mean that the amplifier is a 0.2 per cent amplifier.

L. D. Dialing Under Test

Residents of Englewood, N. J. will have more than eleven million telephones at their dialing finger-tips this fall when the Bell system inaugurates its first test of transcontinental subscriber dialing.

Results of the Englewood experience are expected to act as a guide in expanding the service to other major localities. Cities which may be dialed directly from Englewood are San Francisco, Chicago, Detroit, Cleveland, Boston, Philadelphia, Oakland, Milwaukee, Providence, and Sacramento.

Equipment has been developed which automatically records calling and called numbers, computes time of conversation, and prepares information for billing.



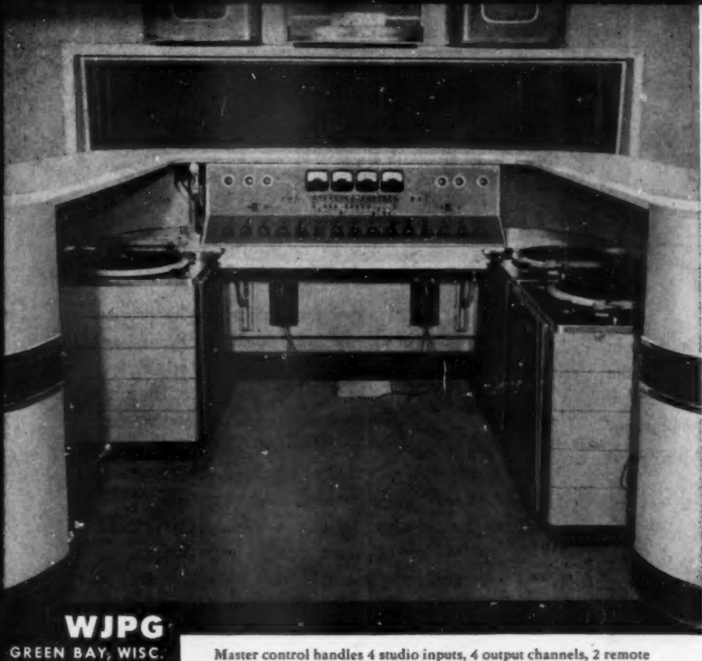
WBAP
FT. WORTH, TEXAS

This master control console, including 16 de luxe audio equipment racks, is part of a modern 6-studio layout—custom-built by RCA. Designed for AM, FM and TV operation, this "In-Line" design handles 16 studio inputs and feeds 10 output channels—simultaneously, or individually, by a pre-set relay system.

Unlimited audio

Two supervisory positions like this one handle 4 studios, 2 outgoing lines. It includes telephone ringdown, remote switching, talkback, monitoring, and cueing. This set-up uses existing RCA Consolettes—makes studio and master control functions possible in one location.

WJAC
JOHNSTOWN, PA.



Master control handles 4 studio inputs, 4 output channels, 2 remote inputs, 3 turntable inputs, cueing, monitoring, talkback. This master control and one sub-master handle all program needs.

A few of the many de luxe units available

- Supplementary equipment for Consolettes—switching systems, extra inputs and outputs, jack strips, ringdown, sound-effects filters, and line equalizers
- Master control equipment—to handle any number of studios
- Matched custom wings for consolettes—for studio and master controls
- Custom racks for relay switching
- "One-man" control layouts
- Master control console combinations
- Studio control consoles
- Custom recording—for separate or simultaneous recording
- Custom recording control turrets
- Mobile recording equipment—disc recorders, tape recorders, record playbacks. Everything including the motor vehicle.
- Audio/Video equipment—custom audio, plus video switching, monitors, stabilizing amplifiers.

facilities.....for SMALL STATIONS MEDIUM STATIONS LARGE STATIONS

RCA fine custom-built studio control systems

With RCA Custom-Built equipment you can extend your audio facilities almost without limit. No matter what size the system, experienced RCA design assures instant, fool-proof switching without program level "pops" or "breaks." Fidelity of sound meets the requirements of the world's severest critics.

Suitable for every AM, FM, and Television station—small, medium, or large—RCA Custom-Built Systems are "individualized" to handle all the studio-control operations anticipated by the individual plant. Any number of station studios may be provided for . . . any number of remote lines . . . any type of master control . . . all the monitoring, talkback, and cueing facilities needed . . . every conceivable facility for controlling program operations and reproducing high-fidelity sound. True cabinet craftsmanship combines durability with function. Handsome styling and finish enhance station prestige.

Consultation on Custom-Built equipment is provided without obligation to every station—any size. Service includes detailed layout proposals, diagrams of equipment and facilities, artist's sketches by RCA functional design experts, thorough counsel by RCA's experienced staff of broadcast specialists. Where plans are already down on paper, RCA will be glad to work from these—co-operate closely with your principals.

Your RCA Broadcast Sales Engineer can tell you about this service. For complete information call him, or write Department 16U, RCA Engineering Products, Camden, New Jersey.

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EDITOR'S REPORT

THE AUDIO SEASON

WITH the advent of the fall months, interest in audio revives because of the end of vacations, the longer evenings in which entertainment is wanted, and an opportunity to work over last year's equipment to incorporate all the new ideas which have turned up during the summer months.

Then, too, there is the Audio Fair to look forward to—definitely the principal audio event of the year. For three days each devotee of this art—or science, depending upon how you look at it—can roam through the rooms and corridors of Hotel New Yorker and see, touch and *hear* the products of the leading manufacturers of amplifiers, speakers, tape recorders, phonograph pickups, and all the many items which go to make up the home music system of his dreams. He sees and studies the construction practices of leading professional equipment manufacturers, and determines ways in which he can adapt their methods of building to his own problems.

The technical sessions of the Audio Engineering Society Convention have been well attended in the past years, and the material to be presented this year should prove to be equally attractive. There need never be a dull moment for anyone who has a deep interest in audio—professional or otherwise.

EMERGENCY WARNING SYSTEMS

Increasing activity in the field of emergency warning systems has opened up a large vista for manufacturers and installers of audio equipment. While the use of sirens has become more or less universal in large cities, it can not be denied that it is difficult for a siren to make more than two kinds of noise—a warble tone or a constant tone—with its consequent inability to give any detailed instructions to large numbers of people. By virtue of the character of a siren's sound, it is alarming; panic at a time of emergency could easily be more dangerous than the event being warned against.

The installation of high-power voice-frequency speakers throughout the business district of a large city would permit some one in authority to give directions which would be of inestimable value at any time—not only during or preceding a war period. Such a system could readily be arranged for instant use by proper authorities, and in case of fires, floods, hurricanes, or any other natural or man-made emergency, nearly everybody in the city could be told just what to do. By suitable arrangements, every radio station could carry the same announcements overriding its then current program, along with all wired music services. In a given area, it should thus be possible to contact a very high percentage of the people with a minimum of effort. Radio stations are, of course, set up now to tie together —in most instances by a radio link.

If it were possible for people to be so directed that their efforts in getting out of the danger zone were effectually coordinated with the needs of the area as a whole, it seems probable that the greatest good would result for the greatest number. Many manufacturers and installers are actively attacking this market, with excellent results being reported to date.

One other advantage that accrues to a system of this type is that strangers in a given city—and most large cities have a high percentage of tourists and visiting business men in their midst at all times—do not have to learn the meaning of signals. The use of the spoken word would leave no doubt as to what was expected of them.

The uses of sound have far outgrown the limiting title given to early installations—"public address." Yet a search for a sound system manufacturer, installer, or operator through the classified telephone directory under the term "sound" leads one to the cross reference "public address." We favor the more general term to describe an industry which is still growing by leaps and bounds.

STANDARDIZATION

While standardization in professional circles is progressing constantly, and with many loose ends being tied up, we hope for some standardization in the plugs, sockets, jacks, and cabling used in non-professional equipment. Input connections to amplifiers are semi-standardized with the adequate and inexpensive pin-plugs and jacks, but there is little uniformity in output connections or in inter-chassis or power supply connections. Any suggestions from individuals or manufacturers would be entertained with interest.

LETTERS

Who'll Volunteer?

Sir:

Would one of your readers allow me to photostat his copy of the parts list for the McMurdo Silver *Masterpiece V*, or can someone please tell me where such a list can be found?

Frederick B. Davis,
12 Normandy Road,
Bronxville, New York

The KT66 Tetrode

Sir:

Your note announcing the arrival of this valve in the U. S. (NEW PRODUCTS, June) does not mention the important differences between the KT66 and the 6L6 when used as triodes. The first difference is that the KT66 as a triode has a maximum anode-dissipation rating of 25 watts compared to 10 watts for the 6L6, and the second is that the KT66 as a triode has an anode impedance about 20 per cent lower than the 6L6. Taken together, these two differences explain why the KT66 is the best choice in amplifiers such as the Williamson.

If any of your readers would like more information on the KT66, I suggest they write to The General Electric Co. Ltd. (of England), Magnet House, Kingsway, London, W. C. 2, England, and ask for Technical Publication TP3, which I can recommend as a useful and interesting booklet (except for the circuit suggested for a stabilized power supply).

To avoid any misunderstanding, I had better add that I am in no way connected with the makers of this valve.

E. F. Good,
Pale Manor Hostel,
Malvern, Worcs.,
England

Transients

Sir:

Advertisements and articles in some of the British journals often mention speaker transient response and the contradictory response-speed-vs.=overshoot design problems.

If the overshoot of a wide-band video amplifier is too great, it can be damped with resistance, or its peaking coil inductances reduced. This is accomplished at some sacrifice in bandwidth and rise-time. In other words, there is a compromise. Some involved compensating and filter-type coupling networks which are applied to pulse amplifiers produce a linear phase shift out to the limit of useful bandwidth, and result in good rise-time, relatively wide bandwidth, and no appreciable ringing. Where fast rise time is required to handle extremely short pulses, on the other hand, one must compromise in the other direction and use series or series-shunt peaking to permit about 2 per cent overshoot, which is tolerable enough for most TV and other pulse applications. Similar problems are encountered in electrical meter movement design where overshoot of 1 to 5 per cent is permitted to obtain the necessary practical response speed. Weston engineers, for instance, point out that by allowing about 5 per cent overshoot, one doubles the response speed of a meter movement. Hence a speaker that does no ringing whatever is not necessarily the ideal design from the transient-response viewpoint.

[*Continued on page 44*]

Space-Charge-Grid Amplifier

MELVIN C. SPRINKLE*

A new low-power amplifier using the space-charge-grid tubes first publicized as audio output tubes almost four years ago. By the designer of the Musician's Amplifier.

FROM TIME IMMEMORIAL, it seems, the audio enthusiast has been searching for wider frequency range and lower distortion in his amplifiers. These desirable features are expensive, and cost is an important consideration to the average audio fan. So, the effort has gone on to get the most for the least. The amplifier to be described represents what is believed to be the highest quality yet attained for the required financial investment. The remarkable performance is made possible by two important components: a new and radically different tube type and a high-quality low-cost output transformer.

In spite of its well known limitations which increase cost, the triode tube has for years been the standby of the audio crowd. The beam-power tube overcame a number of the limitations of the triode, but many builders never accepted the beam power tube as the equal of the triode. Thus the argument has raged for some years on the beam tube vs. the triode, with good points on both sides. Now, the National Union Radio Corp. has developded for commercial use a new tube type which combines the best features of the triode and the beam tube, and which opens a new era in high-quality amplifiers. This tube is known as the NU 2160 and is a space charge tube. Its plate family of curves resembles those of triodes, but its efficiency and drive requirements are like a beam power tube.

The space charge tube has been described in the literature,[1, 2] but for the benefit of those who do not have access to the references, its characteristics are briefly summarized. The space charge tube is a tetrode, with a cathode, two grids, and a plate. The grid nearest the cathode is operated at a positive d.c. voltage with respect to the cathode, the effect being to counteract the negative space charge and produce a larger cloud of electrons at the plane of the first grid. This cloud acts as a virtual cathode. The second grid is then the control electrode, being operated with a negative bias in the conventional manner. The operation of the space charge tube is similar to a triode with a large effective cathode. It should be pointed out that it is not possible to connect an ordinary tube as a space charge tube because so doing would cause excessive current in the first grid. In the NU 2160 the current in the first grid has been lowered by mounting a pair of side rods between the space charge grid and the cathode, and connecting these rods to the control grid. The side rods thus shield the space charge (No. 1) grid from the cathode except in the vicinity of the lateral wires of the grid. They also have an effect in reducing harmonic distortion.

The positive voltage on the space-charge grid is supplied from the plate supply through a 10,000-ohm resistor. The space charge grid is *not* bypassed, and the omission of the bypass capacitor produces three beneficial effects: the power output is increased slightly for a given average cathode current, the output is less affected by changes in external load impedance, and the odd harmonic distortion is reduced. It has been mentioned that the plate current family resembles triode curves. To this must be added the fact that the plate resistance is low—2,500 ohms—the μ of 16 is medium, and the transconductance is 6,500 micromhos. The uniformity and regularity of the plate family indicate that these parameters are fairly constant and therefore the distortion is low. The tube is operated with a bias of about 18 volts on the control (No. 2) grid so that operation out of a resistance-coupled stage or phase inverter is very practical.

Through the courtesy of National Union, the writer was provided with a pair of NU 2160's for experimental use. As of the present, National Union is planning to market the NU 2160 through radio parts distributors, but material uncertainties make the general availability of the tube a question mark. It is also not known whether other tube manufacturers will make space charge tubes for sale through their distribution channels.

Design of Amplifier

Examination of the data sheets provided with the tubes, showed that the tube was ideal for a low-cost amplifier, the power output as calculated being of the order of 6 watts for two tubes in push-pull. The Peerless S-508-A output transformer, originally designed for type 6V6 tubes, has ratings as to plate current and primary impedance which suit it to the 2160. Its design, based on the 6V6 plate resistance, means that it will

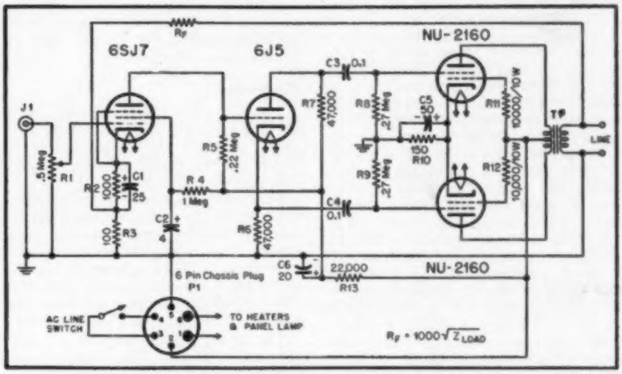


Fig. 2. Schematic of the space-charge-grid amplifier chassis.

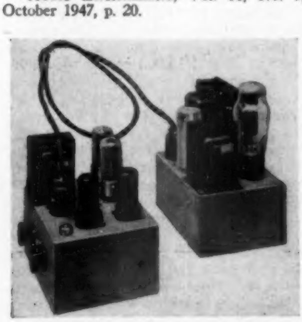


Fig. 1. Separate chassis for the amplifier and power supply simplify mounting in many applications.

* *Peerless Division, Altec Lansing Corp.*

[1] *Electronics,* Vol. 20, No. 8, August 1947, p. 121.

[2] AUDIO ENGINEERING, Vol. 31, No. 9, October 1947, p. 20.

perform even better at low frequencies with the low-plate-resistance space-charge tube. Its physical size is small, and its price—scarcely higher than a large replacement type transformer—puts it within the reach of the most modest budget. This transformer has low insertion loss, wide frequency response, and ability to deliver power at frequency extremes. The performance data on the complete amplifier to be given later attests to this.

The amplifier itself is simple and with the possible exception of the space-charge stage is conventional. As will be seen from *Fig.* 2 it consists of a pentode amplifier stage using a type 6SJ7, direct coupled to a 6J5 split-load phase inverter which drives the output tubes. The circuitry of the pentode stage is conventional, the only precaution being to use an adequate bypass capacitor on the screen. The split load phase inverter is also well known and conventional. The writer has found it to be about as good a circuit as is available, having none of the drawbacks sometimes ascribed to it. One of the big advantages is that it lends itself so well to direct coupling from a preceding stage. Use of direct coupling extends the frequency response of the stage to d.c. and eliminates coupling networks which can cause phase shift and low-frequency attenuation. There are only two coupling capacitors in the amplifier, from the phase inverter plate and cathode to the power amplifier grids. The low-frequency response in the entire amplifier is very good, much better than the transformer curves alone might lead one to believe. It should also be pointed out that the direct coupling system used here is almost automatic in its action to provide optimum operation for both stages once the plate voltage of the preceding stage is brought close to the positive voltage on the phase inverter cathode. There is plenty of good clean signal from the phase inverter to work directly into the space charge control grids and give full power output.

Output Stage

The space charge tube circuit differs from the usual push-pull beam power circuit in one respect. Two 10,000-ohm 10-watt resistors are used to provide the space charge grid voltage. It is necessary to use a separate resistor for each tube. As has been pointed out previously, these space-charge grids are *not* bypassed. The cathodes are tied together and go to ground through a 150-ohm resistor, which is heavily bypassed. The tubes are operated more Class AB_1 than recommended by the manufacturer, as tests with intermodulation equipment showed that reducing the bias increased the distortion slightly at the higher output levels.

Inverse feedback around the amplifier is sufficient to reduce hum, noise, and distortion almost to the vanishing point at the usual levels. The source impedance is lowered to 2.5 ohms on the 16-ohm tap. Connections are available on the output transformer to match loads of from 4 to 16 ohms. Values for the feedback resistor for various load impedances are given in *Fig.* 2.

Construction

The amplifier is constructed on an aluminum chassis 5×7×3 in. There is plenty of room for all parts, most of which are mounted on two terminal boards. One board is used for the pentode and phase-inverter components, while the other holds the coupling capacitors and resistors for the space charge tubes. A ground bus is used with connection to the chassis at the input so as to avoid chassis currents and hum. The controls are simple—a volume control, a pilot lamp and an a.c. line switch.

The power supply, *Fig.* 3, is simple and conventional. The power transformer is rated at 120 ma, and the amplifier draws just about that current. After 12 hours continuous use in 75° F. ambient, the transformer is just warm. A 6-wire cable is used to connect the power supply to the amplifier. The a.c. power line is run to the amplifier so that there is no possibility of the power supply becoming energized, without its load being connected even if the a.c. power switch is not installed. If no switch is desired, terminals 3 and 4 of the plug must be wired together.

The two-chassis system was employed for this unit—one chassis being used for the amplifier and another for the power supply—so that the amplifier can be placed wherever desired and the power supply can be located at some remote point. Furthermore, they can be placed side by side, end to end, or even stacked if required. One large chassis can be used if the amplifier and power supply are to be constructed as a single unit.

Performance

At the beginning it was stated that this amplifier was intended as a high-quality, low-cost unit. It is believed that this has been accompilshed, as will be seen from the performance data. The NU 2160 was not intended as a high-power tube, and hence the power output is limited when compared with 6L6 tubes. The useful power output of the amplifier in a load resistor connected to output transformer secondary is about 5.5 watts, based upon the point where the intermodulation begins to climb rapidly. This power rating compares very favorably with the data sheet which gives the power in a resistive load connected from plate to plate as 6 watts for 2 per cent harmonic distortion, as shown in *Fig.* 4. The single-frequency sine-wave output power before the waveform begins to be distorted (about 5 per cent) is 7.5 watts. The power output as a function of frequency is given in *Fig.* 5. It is the power output at frequency extremes that makes an amplifier sound good and which is reflected in the low intermodulation distortion. Power output at frequency extremes is a function

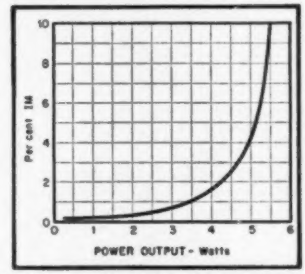


Fig. 4. Intermodulation distortion curves for the amplifier indicate its excellence for low-power applications.

of the output transformer, as tube manufacturers do not put frequency restrictions on their audio power tubes, their measurements being made on a resistive load connected directly to the plates.

The absolute gain of the amplifier is 81 db, and is practically constant from 20 to 20,000 cps., the maximum departure being about 0.2 db at the limits. It must be pointed out again that frequency response is not nearly as important in the "ear appeal" of an amplifier as power output as a function of frequency. The output transformer used has a rated frequency response of no more than 1 db down at 30 and 15,000 cps, yet the amplifier frequency response is much better. The answer lies in the fact that inverse feedback improves the frequency curve. However, inverse feedback will not help power output measurements as a function of frequency to a great extent. Hence the power curve is more important.

The total noise level, including hum, is – 51.2 dbm which is 88.7 db below the rated output of 5.5 watts. The distortion was measured with an intermodulation set using frequencies of 40 and 2000 cps. Up to within 1 db of the rated power the IM distortion is no more than 2 per cent, and at 2 db below rated power the IM is 1 per cent or less. These are entirely negligible amounts.

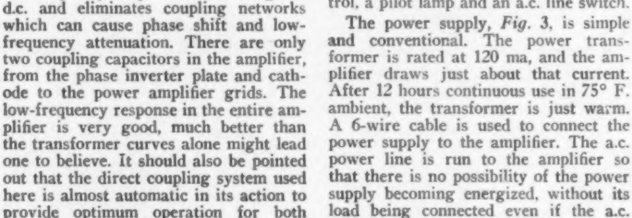


Fig. 3. Schematic of the power supply chassis.

An efficient speaker with 0.1 watt input at 1000 cps will produce a sound level of around 83 db. This sound level has been classified on the *Electronic Industries* sound level chart as "very loud radio in home." At a power output of 0.1 watt the IM distortion in this amplifier is about 0.15 per cent and at a 10 db higher level, which is roughly representative of peaks in the program material, the IM distortion is 0.25 per cent. Thus at all usable levels, the IM distortion is too small to worry about.

The total cost of the parts to build this amplifier and power supply, using the transformers specified for its performance and other parts of first grade is about $35.00. This does not include the space charge tubes since no firm price has been put upon them. However, they should certainly be no more expensive than 6L6 tubes, for example. Thus the cost puts it well within the reach of the audio enthusiast who longs for a better amplifier but whose "Chancellor of the Exchequer" has other ideas on what to buy.

It was not intended that this amplifier take the place of a deluxe amplifier, such as the Musician's Amplifier, where the ultimate in quality is desired and where the performance requirements are rigorous. This amplifier "folds up" at power levels where the Musician's Amplifier is still below 2 per cent IM. However, this amplifier is especially commended for the average home, especially when cost is an important consideration. At the 1950 Audio Fair it was compared on A-B test with larger amplifiers of equal quality and until the level became so loud that it was deafening, there was no audible difference. In the author's home it has done everything that a home amplifier is called upon to do. There is not enough gain to operate directly from a magnetic pick-up cartridge but with a preamplifier, many of which have been described in these pages, it reproduces all that is on a record. There is, however, plenty of gain for an FM tuner.

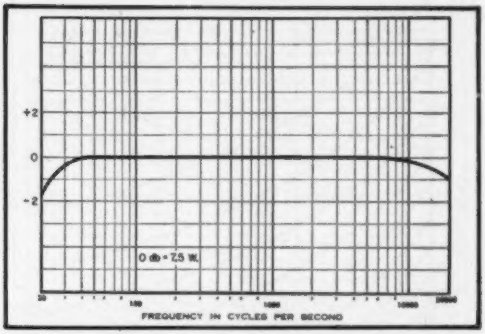
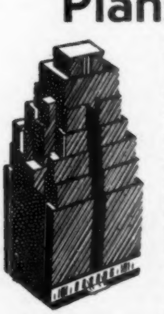


Fig. 5. Curve showing power output vs. frequency over the range from 20 to 20,000 cps.

Parts List

C_1	25 µf, 25 v. electrolytic
C_2	4 µf, 450 v. electrolytic
C_3, C_4	0.1 µf, 600 v. paper
C_5	50 µf, 50 v. electrolytic
C_6, C_7	10-10 µf, 450 v. electrolytic (FP type)
C_8, C_9	40-40 µf, 450 v. electrolytic (FP type)
L_1	Peerless C-325-A filter choke. 10 H. at 120 ma; d.c. resistance, 240 ohms
R_1	0.5 meg, audio taper vol. control
R_2	1000 ohms, 1 watt
R_3	100 ohms, ½ watt
R_4	1.0 meg, 1 watt
R_5	0.22 meg, 1 watt
R_6, R_7	47,000 ohms, 1 watt (5% or matched)
R_8, R_9	0.27 meg, ½ watt
R_{10}	150 ohms, 10 watt
R_{11}, R_{12}	10,000 ohms, 10 watt
R_{13}, R_{14}	22,000 ohms, 1 watt
R_{15}	0.22 meg, 1 watt
T_1	Peerless S-508-A output transformer. Pri. Z: 8000 ohms plate-to-plate; Sec. Z: 4, 8, 12, 16 ohms. Frequency response ±1 db from 30 to 15,000 cps.
T_2	Peerless R-480-A power transformer. 350-0-350 v. at 120 ma; 5 v. at 3 amps; 6.3 v. at 5 amps.
V_1	6SJ7
V_2	6J5
V_3, V_4	National Union 2160
V_5	5U4G

Plans All Set For 1951 Audio Fair



Hotel New Yorker

The third Annual Audio Fair, scheduled for November 1, 2, and 3, in Manhattan's famous Hotel New Yorker, will complete the metamorphosis which has seen the exhibit develop in just three years into one of the country's major electronic events.

Beginning back in 1949 with 50 exhibitors and a total attendance of 3000 visitors, the Fair occupied only a portion of the New Yorker's sixth floor. Even though the '49 showing was considered a success, its most enthused supporters were forced to admit that, unless 1950 brought a great increase in both commercial support and in attendance, there was little chance for the Fair to achieve the prominence they had hoped for.

Came 1950 and things happened. The number of exhibitors nearly doubled, and attendance jumped almost *300 per cent.* An inkling of how firmly The Audio Fair had staked its position in the electronic industry is found in the graphic words of an *Atlantic Monthly* author who wrote, ". . . the mood of the visitors was exultant and anticipatory," and in review articles which appeared in such magazines as *Saturday Review of Literature, Pageant,* and *Pathfinder,* not to mention most of the recognized technical publications. Truly, The Audio Fair had arrived.

The Fair is held each year in conjunction with the annual Convention of the Audio Engineering Society. Growth of the Convention has parallelled that of the exhibit, and today it is regarded as a symposium of world-wide prominence in every aspect of audio engineering. This year AES members who attend the Convention will be treated to technical papers covering many departures from convention in the field of audio design and application. The technical sessions are assuming an international flavor with the announcement that engineering representatives of well-known European manufacturers will participate.

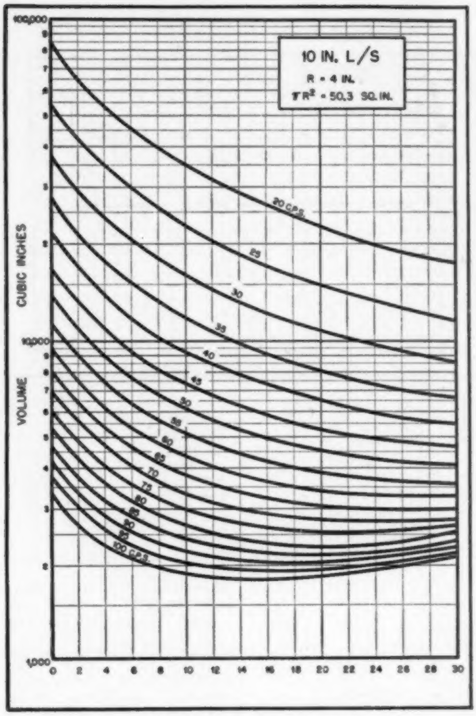
Theme of the Fair for '51 is *Audio on the Contemporary Scene.* Exhibits are being planned to emphasize and dramatize the full stature of audio and the influence it exerts on people in all walks of life. Items on display will serve the interest of everyone from the music lover looking for an economical assembly of living-room equipment to that of the government official whose responsibility lies in the use of sound devices for psychological warfare.

In addition to commercial displays, there will be a joint showing by Ohio State University and a segment of the Armed Forces. The university exhibit will be built around a dynamic demonstration of the newest in scientific instruments for checking hearing characteristics. The visitor who desires will be afforded the opportunity of using the equipment to determine the sensitivity of his own hearing. The Armed Forces' portion of the display will feature the use of similar devices in connection with various military projects.

It can thus be seen how thoroughly the 1951 Audio Fair will realize the prime objective of its founders—". . . to provide an instrument of national research as well as a medium for bringing high-quality audio before the public's eyes and ears."

Irrespective of one's audio interests—whether he be a top-flight design engineer, a broadcaster, or a music lover—he must attend The Audio Fair to keep well informed in his chosen field. As in previous years, admission to all exhibits is free, and technical sessions of the Convention are subject to a small attendance charge.

More emphatically than ever the slogan of the first Fair prevails in '51—*The Audio Fair is YOUR Affair.*



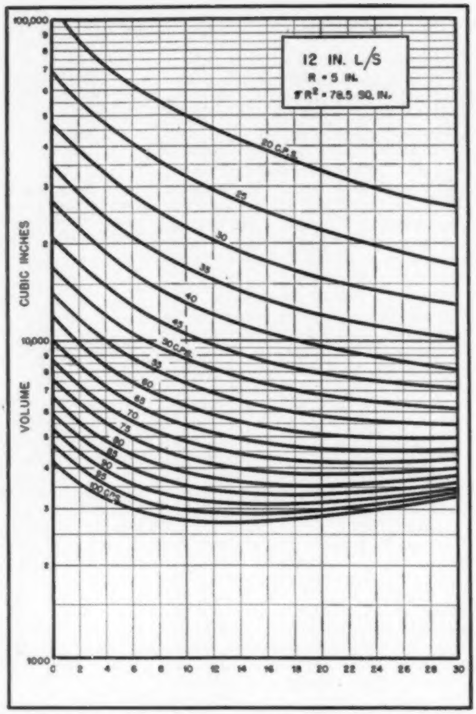


Fig. 1 (left). Curves showing tunnel length for 10-in. speakers resonant from 20 to 100 cps in a wide range of cabinet volumes. Fig. 2 (right). Curves for 12-in. speakers.

Design Data for a Bass-Reflex Cabinet

J. A. YOUNGMARK*

The charts presented by the author will simplify the selection of the dimensions for a satisfactory bass-reflex speaker cabinet.

If the full benefits of a high-quality audio system are to be realised, it is, of course, vitally important to ensure that the loudspeaker system is equal to its appointed task. Fundamentally, this usually resolves itself into the provision of a suitable means of separating the radiation from the back and front of the loudspeaker cone, among certain other considerations, and the horn is notably efficient in such a connection. Unfortunately, the bulk of a horn such as would be required at the lower end of the audio range renders its use difficult, to say the least, and it is therefore obvious that some compromise must be made.

One such compromise between efficiency and size can be made by using the corner of a room as the outer section of the horn and a noteworthy example of this is the Klipschorn. This consists of a frequency-divided system in which both the high- and low-frequency units are horn loaded. It is, however, rather complex in design and quite expensive to produce, whilst another arrangement, the Pyramid Corner Speaker,[1] is not very suitable where only a single unit is used.

In the normal domestic installation there is much to recommend the bass-reflex design first described by Thuras.[2] Correctly designed, it gives increased power handling capacity, reduces the cone amplitude distortion at the resonant frequency, and at the same time gives additional output at this frequency. It may be built in a compact form and is relatively free from phasing difficulties. Although this type of loudspeaker system has never been so popular in Europe as in the U. S. it is now in fairly wide use there.

The theory of the reflex cabinet has been published, among others, by Hoekstra[3] and Smith.[4] The treatment which follows is based mainly upon their analy-

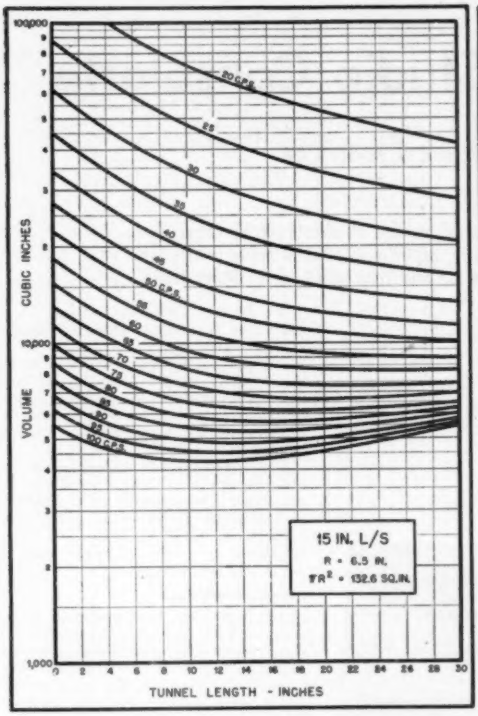
* *Goodman Industries, Limited, Lancelot Road, Wembley, Middx., England.*

[1] W. E. Gibson and J. J. Andrea, "A symmetrical corner speaker," Audio Engineering, March 1950.

[2] A. L. Thuras, U. S. Patent 1,862,178 (1930).

[3] E. C. Hoekstra, "Vented loudspeaker enclosures," *Electronics*, March 1950.

[4] F. W. Smith, "Resonant loudspeaker enclosure design," *Communications*, August 1950.



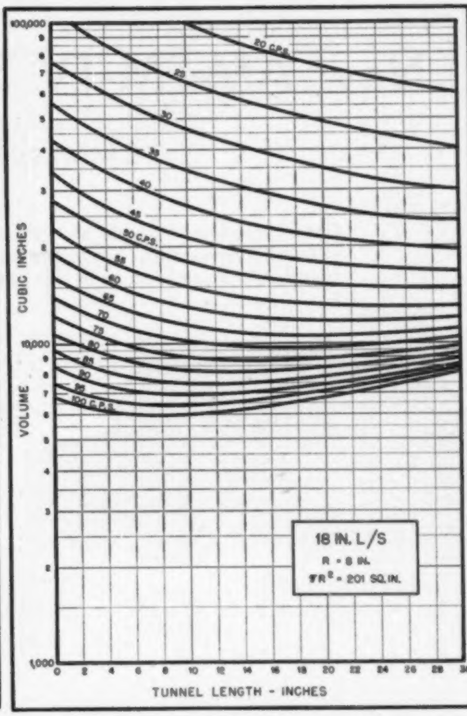


Fig. 3 (left). Curves of tunnel length for 15-in. speakers resonant from 20 to 100 cps in a wide range of cabinet volumes. Fig. 4 (right). Curves for 18-in. speakers.

sis in deriving an expression for the resonant frequency of any reflex cabinet and provides four sets of curves from which cabinets for the four most popular sizes of speaker (10, 12, 15, and 18 in.) can be designed without calculation.

The stiffness reactance of the air enclosed in a volume V is:

$$X_s = \frac{-j\rho C^2}{\omega V} \qquad (1)$$

where

ρ is the density of the air,
C is the velocity of sound,

and $\omega = 2\pi f$ (f being the frequency).

The cabinet is assumed to have a circular hole of radius R, provided with an internal tunnel of length L. The mass reactance of the air in such a tunnel mounted in an infinite plane baffle has been shown by Rayleigh[5] to be:

$$X_m = \frac{j\rho W}{\pi R^2}\left(\frac{K_1(2kR)}{R^2k^2} + L\right) \qquad (2)$$

where

$K_1(2kR)$ is a Bessel Function of the first order

and $k = \frac{\omega}{c}$

Equation *(1)* represents the air load on the vent due to the air outside the cabinet, and equation *(2)* represents the mass of air in the tunnel. When the dimensions of the vent are small compared with a wavelength, this reduces to:

$$X_m = \frac{j\rho\omega}{\pi R^2}\left(\frac{16R}{3\pi} + L\right) \qquad (3)$$

When this cabinet is resonant, $-X_s = X_m$

$$\frac{j\rho C^2}{\omega V} = \frac{j\rho\omega}{\pi R^2}\left(\frac{16R}{3\pi} + L\right) \qquad (4)$$

$$V = \pi R^2 \left(\frac{C^2}{\omega^2} \times \frac{1}{1.7R + L}\right)$$

At the resonant frequency given by

[*Continued on page 46*]

[5] Rayleigh, *"Theory of Sound,"* Vol. 2, p. 306.

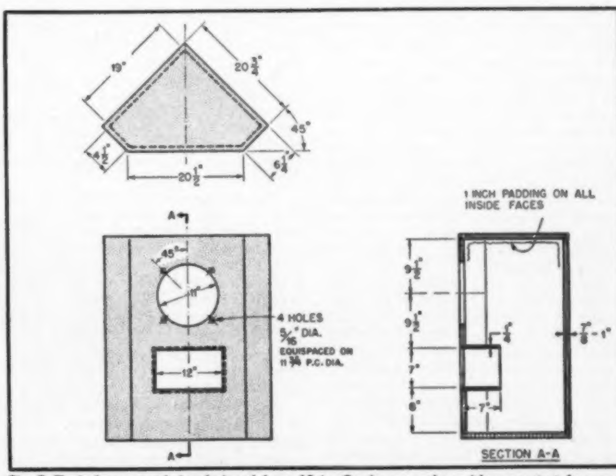


Fig. 5. Typical corner cabniet designed for a 12-in. Goodman speaker with a resonant frequency of 55 cps, which can be used with a speaker resonant at 75 cps by removing the tunnel.

New AM-FM-TV Studio Consolette

P. W. WILDOW and G. A. SINGER*

Control facilities for small stations need not be as elaborate as those for network headquarters, but operation is expedited considerably if similar functions are provided, as in this newest addition to the broadcast field.

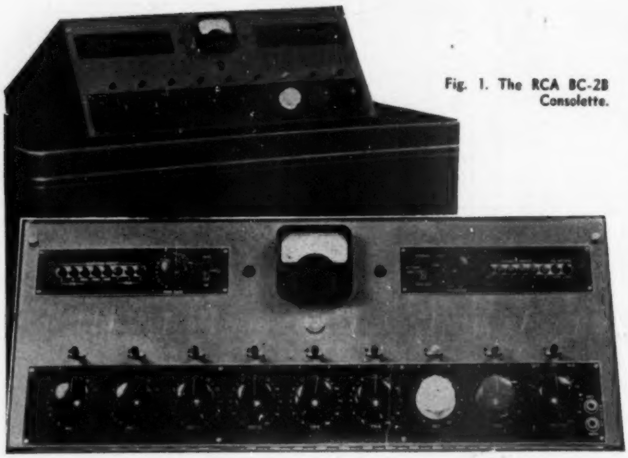


Fig. 1. The RCA BC-2B Consolette.

MANY DIFFERENT TYPES of audio systems are available for use in the broadcasting studio control room to perform the functions of amplification, mixing, switching, and regulating of the program. These systems may range from elaborate custom-built equipments utilizing rack mounted amplifiers with control desks containing only the operating controls, to very simple portable equipment adapted to studio use.

The consolette which is between these extremes offers the advantage of containing in a single package all the essential elements necessary for efficient programming. It requires a minimum of wiring at the installation and takes up little space. Because regular factory production methods are used, its cost is appreciably lower than that of more complex equipment.

The type BC-2B Consolette described in this article is a new design, engineered to fulfill the control room requirements of the majority of AM-FM and TV stations. The final design of this consolette reflects the combined thinking of broadcast engineers with long experience in the operation and design of broadcast audio equipment. As a result, several new operating features and recently developed tubes and components are incorporated in its construction.

* *Engineering Products Dept., Radio Corporation of America, Camden, N. J.*

Facilities

The consolette may be used to control either one or two studios. In addition, it will serve an announce booth, a control room microphone, two turntables, a network and five remote lines. The monitor amplifier may be used for monitoring, auditioning, receiving and sending cues, talk back to studios, and as an emergency line amplifier. Except for the power supply, the consolette is completely self-contained.

The arrangement of circuits and controls is such that operation is simple and straightforward as shown in *Fig.* 1. Switches and faders are clearly marked with their function, and related control knobs are made of the same color plastic material. Electrical and mechanical interlocks are provided in the audio and control circuits to prevent improper operation. Even inexperienced or new personnel are able to learn quickly how to operate the consolette.

The consolette is designed to mount on a flat-topped desk or table, yet the sloping front panel design affords maximum visibility into the studio floor area. The consolette which is finished in two-tone umber gray will blend in well with other RCA television studio control equipment.

All external connections are made to two terminal blocks which become accessible by lifting the top cover. As seen in *Fig. 2*, every electrical component is easily accessible for inspection, adjustment, cleaning and replacement.

The front panel swings forward bringing switches and attenuators in full view. The amplifiers are mounted on a movable frame which swings up, making the underside accessible. The amplifiers are on individual chassis which can be removed.

General Description

Figure 3 is the block diagram of the consolette. Of the six microphone inputs, three studio microphones are connected directly to the pre-amplifiers, and by means of a switch, the input to the fourth pre-amplifier may be selected from the control room, the announce booth, or the fourth studio microphone. The two turntable inputs connect directly to the mixers. In application where a booster amplifier is not included as part of the turntable, an additional dual-preamplifier may be installed in a space provided within the consolette. One input is reserved for a network line and one of five remote lines may be selected by means of a push-button switch. A line transformer is included for isolation and impedance matching.

Each of the eight possible simultaneous inputs is controlled by a high-level mixer. The mixer circuit is of the series-parallel type which offers the lowest loss. Both turntable mixers have "built-in" cueing switches which connect the turntable outputs to an external cueing amplifier when the mixer control is turned to the OFF position.

By means of key switches, the output of each mixer may be connected to either the program bus or the audition bus. The program bus is permanently connected to the input of the program amplifier. The output of the program amplifier is connected through the LINE-OUT switch and a 6-db pad to the output line terminals. The purpose of the pad is to equalize amplifier and line impedances.

The input of the monitor amplifier can be selected by means of a push-button switch. There are three talkback buttons which connect the control room microphone to the monitor amplifier and permit the operator to talk to Studio A, Studio B and the remote lines respec-

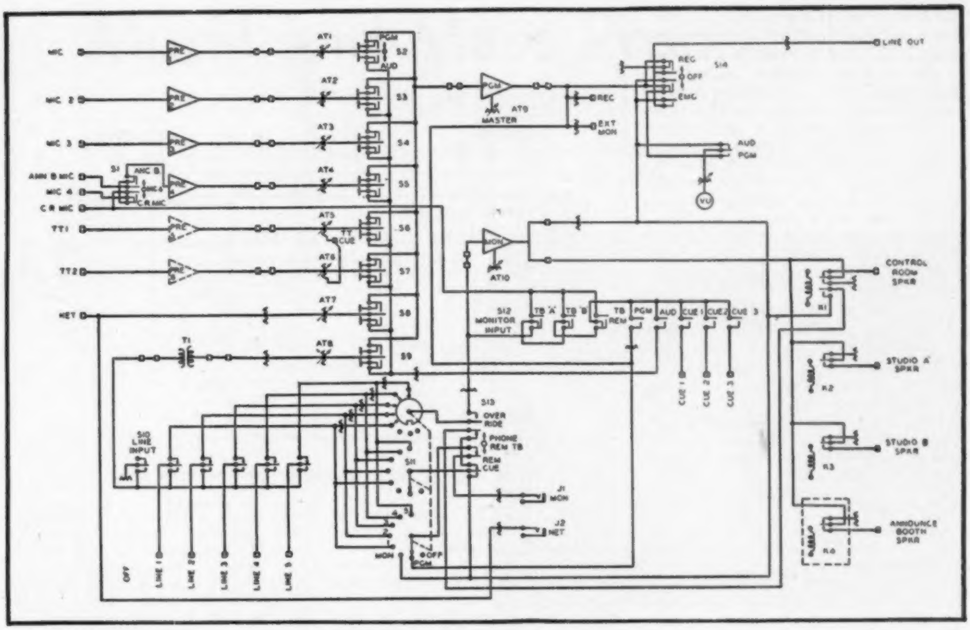


Fig. 3. Simplified block diagram of BC-2B Consolette.

tively. The fourth push-button bridges the monitor input across the output of the program amplifier for monitoring the outgoing program. The fifth button connects the input of the monitor amplifier to the audition bus and the remaining three push buttons connect it to cue lines.

Sometimes it is not known over which remote line a program will be fed. In such a situation, the "override" feature is helpful. By operating the OVERRIDE switch S_{13} all remote lines are connected to the input of the monitor amplifier and a call coming in on any one of the lines will override the signal coming from the monitor speaker.

The monitor amplifier may also be used to send cues over a remote line, and this is accomplished by throwing switch S_{13} to the REMOTE CUE position. The remote line, over which the cue is sent, is selected by the switch S_{11}. An electrical interlock on the line selector switch S_{10} prevents cue from being sent over a line which is in use to receive a program from a remote location.

With switch S_{13} on the PHONE-REMOTE TALKBACK position, the monitor phone jack J_1 is connected through S_{11} to the remote lines, the program and the monitor amplifier. This position is also used to talk back over any remote line. It is thus possible to carry on a two-way conversation between the control room and a remote location.

Should the program amplifier fail, the monitor amplifier may be used as a line amplifier. To do this, the mixer output switches are thrown from the PROGRAM to the AUDITION position. The audition button of the monitor input switch S_{12} is depressed and the line out switch S_{14} is thrown to the EMERGENCY position. The monitor gain control acts as the master gain control under those circumstances.

The VU meter can be switched to indicate the output level of either the program line or the monitor amplifier. Brightness of the lamps illuminating the meter scale is adjustable to suit operating conditions. This is of particular advantage in TV control rooms where the light level must be kept low. The two sets of push-button switches are of the cam-operated type with leaf-spring contacts which are inherently quiet, easy to maintain and give many years of reliable service.

Overall length of the consolette is 33 in., the depth 21½ in., and the height 11¼ in. The total weight is 114 pounds. Knockouts for cable conduits are provided in the bottom and rear sides.

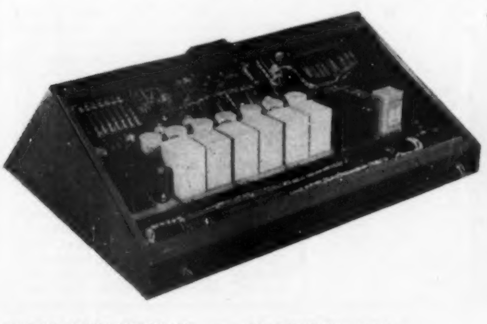


Fig. 2. Rear view of the consolette with the cover removed to show accessibility of equipment.

Amplifiers

The amplifiers are of a new design which utilizes miniature tubes in all stages except the output stage of the program and monitor amplifiers. Negative feedback is employed to stabilize gain and to reduce noise and distortion.

The preamplifier utilizes a 12AY7 twin triode for its two stages of amplification. This tube is designed especially for low-level amplifiers. It affords exceptionally low hiss and hum, and minimizes microphonics. The 12AY7 is also used in

the first and second stages of the program and monitoring amplifiers. Two identical preamplifiers are mounted on a chassis.

The program amplifier consists of four stages, with a potentiometer gain control inserted between the first two. A 5879 pentode, which is also a low-noise tube is used in the third stage, and a 6V6 beam power tube is employed in the final stage. The first and second stages of the monitor amplifier are similar to those of the program amplifier. The third stage and phase inverter utilize a 12AX7 twin triode. The output stage consists of a pair of 6V6's in a push-pull circuit.

Long tube life was considered in the choice of all tubes and in the selection of operating conditions. Pin jacks provided for measuring the cathode voltages of the amplifier tubes facilitate checking the condition of tubes and circuits. The amplifier chassis float on rubber grommets which diminish the transmission of vibrations and further reduce microphonics.

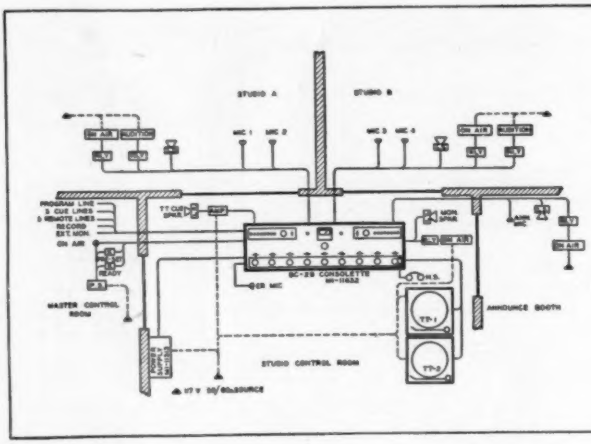


Fig. 4. Simplified diagram showing a typical two-studio station.

Relay Circuits

As shown in the installation diagram, *Fig.* 4, a loudspeaker may be installed in each of the studios, the control room, and the announce booth. These speakers may be used for monitoring, cueing, and talk-back from the control room. In order to prevent acoustical feedback, it is essential that a speaker be turned off whenever a microphone is turned on in the same room. Also, when a studio is on the air, it should be impossible to talk-back or otherwise interrupt the program in progress.

Fast-acting speaker-muting relays are therefore provided for both studio and the control room speakers. Space and wiring are provided for the addition of a relay to control the announce-booth speaker if desired.

The relays are operated from a 24-volt d.c. supply which is part of the consolette power supply. Contacts on the microphone selector S_1, the mixer switches S_2, S_3, S_4, S_5, and the LINE OUT switch S_{11} provide the necessary control and interlocking features.

If studio warning lights such as ON AIR and AUDITION are to be used, these lights may be controlled by a set of warning light relays. Power for actuating these relays is furnished by the consolette power supply and operation is controlled by the speaker relays and additional contacts on the consolette key and push-button switches.

The control circuits are normally connected for two-studio operation. If it is desired to use all microphones in a single studio, the circuit may easily be adapted for this type of service by changing a few jumpers on a terminal board.

Power Supply

The power supply, *Fig.* 5, furnishes plate and heater power to the amplifiers and 24-v.d.c. to the relays. It requires an input power of 150 watts at 100–130 v., 50–60 cps. The B voltages are rectified by a 5R4 and filtered through separate RC filters for the preamplifiers, program amplifier, and monitor amplifier. Two potentiometers are provided to adjust the hum level to a minimum: one for the preamplifiers, the other for the program and monitoring amplifiers. Power for the relays is obtained from a separate transformer and rectified by a selenium rectifier. The power supply is housed in a dark umber gray cabinet which may be hung from a wall or, by means of suitable brackets, mounted on a standard amplifier rack. The power switch and fuses are accessible from the front. After opening the cabinet door, the chassis may be swung out to provide access for installation and service. The external dimensions are 10⅜ in. high, 14¾ in. wide, and 8⅛ in. deep, and the weight is 32 pounds.

Where extreme reliability of service is required, a standby power supply, of the same type as the regular power supply may be installed. A switch is used to transfer power from one supply to the other.

Fig. 5. Power supply used with the consolette.

Anyone Want to Page a Bee?

The tweeter to end all tweeters is included in a new English loudspeaker system which will be described in a technical paper at the Convention of the AES this Fall, and exhibited at the 1951 Audio Fair.

Claimed by the manufacturer to have a linear frequency response up to *30,000 cps*, the tweeter consists of a 0.00025 in. thick aluminum ribbon suspended in a strong magnetic field, and horn-loaded to give both front and back radiation.

The system is known as the Corner Ribbon Loudspeaker. Although the high-frequency unit represents most radical departure from conventional design, the system contains many other features worthy of engineering note.

Music and Mass Production

JEROME GOODMAN*

A brief discussion of some of the factors influencing the planning and scheduling of a "music while you work" program.

Before World War II, about five hundred industrial workers listened to specially prepared music as they worked; today more than five million work with the aid of music[1]. During the war more than six thousand American war plants used music[2], and the probability is great that a great many more will use it in view of the present national emergency. An example will suffice to show why the use of industrial music is so widespread. At the highly mechanized Lily-Tulip Cup Corporation 86.1 per cent of the employees agreed that music helped to reduce fatigue; 93.3 per cent said it broke up the monotony of the work; 95.2 per cent said it made the time go faster; 94.3 per cent said it made the work more enjoyable; 91.4 per cent said it gave them a lift; 82.8 per cent said it kept them from getting nervous and cross. Only 1 per cent complained of interference with work or nervousness caused by the music. Efficiency was up 10 per cent in the work of 63.4 per cent of the employees, while quality improved 35.7 per cent.[3] These figures were collected after music had been in use for a period of six years.

It is the purpose of this article to show how the psychological responses of the individual are utilized by the supervisors of industrial sound and music systems to increase production and to cut costs.

Typical industrial music installation in the mounting room of the Tube Division, Sonotone, Corporation, Elmsford, N. Y. The work performed in this department is well suited to the use of varied music periods.

The conditions under which music serves as an aid to production are limited to specific manufacturing processes. These processes are varied and can be found in a great many industries. To see why this is so an examination of modern production techniques will be necessary.

Problems Due to Mass Production

The widespread mass production system sublimates the instincts of the artisan or craftsman who derives much satisfaction from creating an object and working on every detail of it from its inception to its completion. A worker in a large industry today does not occupy a position in which he can create something; he works, rather, on one small detail of the object during his working day. His work may consist, for example, of turning one screw on a large object that passes by him, perhaps twice every minute. It is easily seen that such repetitious tasks, with the great fatigue and monotony that accompany them, can be emotionally unwholesome for the individual worker.

In order that this fatigue and monotony be kept to the lowest possible level, the workers chosen for tasks of the sort described above are screened by psychological testing procedures that determine their fitness for monotonous jobs. For example, taxi-cab drivers in some places are selected because they possess several psychological attributes that make them fit for driving in traffic. One of these "attributes" is an intelligence quotient (I.Q.) of about 90 per cent. Studies have shown that those with an intelligence quotient much above or below this figure have a tendency toward many accidents. The driver whose I.Q. is below 90 per cent does have the ability to apply the concentration to driving in traffic that is necessary to avoid accidents; while the driver above 90 per cent does not have to apply his total mental capacity to the task of driving. This more intelligent driver is apt to daydream and in this way to be the cause of accidents.[4] Normal I.Q.'s range from 90 to 110 per cent.

Fatigue and boredom manifest themselves in ways that are expensive to management. Workers come in late; they

[*Continued on page 44*]

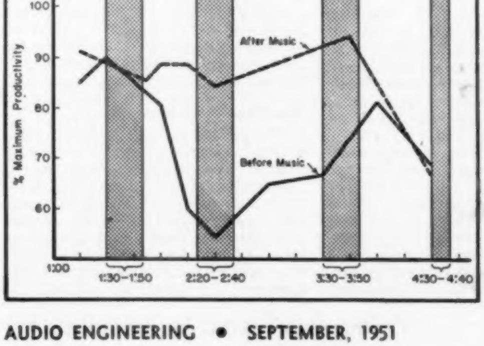


Fig. 1. Graphical representation of production efficiency before and after use of music in a typical plant. (After Burris-Meyer.)

* *79 Corbin Place, Brooklyn 35, N. Y.*

1 R. L. Cardinell and Harold Burris-Meyer, "Music in industry today." *J. Acous. Soc. Am.* July 1947.

2 E. J. Duck, "Music as a modern industrial tool." *Education,* March 1949.

3 A. Flack, "Make your plant a safe, pleasant place to work." *Fact. Mgt. and Maint.,* Nov. 1949.

4 Richard W. Husband, "*Applied Psychology.*" New York: Harpers, 1947.

A Studio Controlled Remote Amplifier

R. S. HOUSTON*

Describing a simple unit which eliminates the need for a control operator in two-microphone remotes by permitting individual control of the microphones from the main studio.

There comes a time in almost every station's activities when an emergency remote comes up, and there is no manpower convenient to handle it. Or, in the case of numerous smaller stations, it is necessary to "ghost" remotes, as a manpower economy measure. On many remotes, two microphones are required. This makes mixing a difficult problem, without an operator present, since usually when one mike is in use, various unwanted sounds and disturbances are picked up on the unused one. If both mikes are in parallel, or fed through separate, fixed-gain faders, this problem becomes acute, since there is no way of controlling the blending of the two mikes. Only the output of the whole amplifier can be controlled by the remote fader at the studio. Numerous schemes have been devised to disable one mike, or even operate them alternately by impulses from the studio. However, with the system described here, it is possible to ride gain continuously on both mikes from the studio control room, thus controlling both the mixing and the output. In this way, the quality of the program can be improved considerably, without the expense or trouble of having a man present at the pickup point.

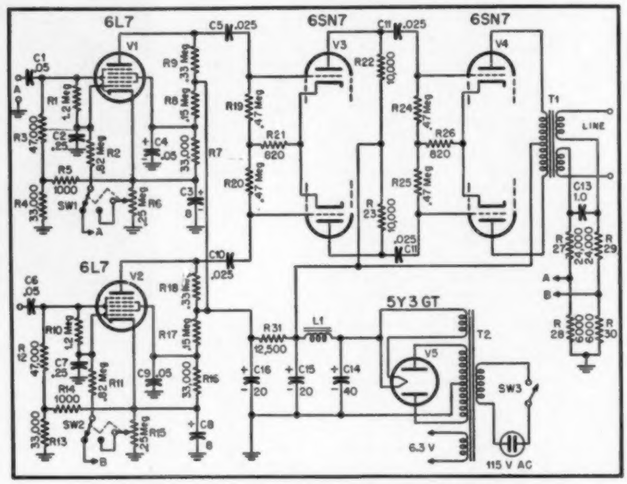


Fig. 1. Circuit schematic for remote gain controlled amplifier.

Circuit Analysis

The reader will recognize the input circuits of *Fig.* 1 as those used by a large manufacturer as a remote control device for public address systems. The circuit is employed for its intended purposes here, with variations. The cathode-coupled phase inverter-mixer was a contrivance of the author some ten years ago. Variations of it are seen frequently today. It will be discussed later in the text. The input and preamplifier circuit uses the two grids of a 6L7 to combine the audio signal with a variable bias voltage to control the gain of the tube itself. The signal is fed into grid *3*, which is self-biased in the normal manner by connecting the grid return at the negative end of 1000-ohm resistor R_5. However, through the bleeder circuit from the high voltage consisting of R_4, R_5, R_7, and R_8, the cathode of the 6L7 is raised to a potential of some 30 volts positive. The bias on the gain-controlling grid, G_1, is varied by moving the slider on potentiometer R_6 between the cathode and ground. Thus G_1 can be at cathode potential, allowing full gain, or at 30 volts negative with respect to the cathode, cutting off the tube. Resistor R_1 is the grid load and is bypassed to ground by C_2. D.c. coupling of G_1 and G_3 through R_1 gives additional control of the output signal by applying bias to both grids. Under these conditions, the full output of the tube can be realized, thus allowing for extra gain for unusual situations.

The switches Sw_1 and Sw_2 are mounted on the back of R_6 and R_{15} respectively, and perform the operation of changing from local to remote control. When the controls are rotated away from the minimum settings, the switches connect the grid-biasing circuits to the internal bias supply, allowing normal manual operation. With extreme counterclockwise rotation, the switches connect the 6L7 grids circuits to the external control source, permitting operation from the studio. Voltage for these controls is supplied over each side of the metallic phone line, operating against a ground return. The line must be split to allow separation of the respective control voltages, one side controlling channel A, the other side controlling channel B. This is easily accomplished by having a split winding on the output transformer at the amplifier, and on the terminating coil at the studio. Each side is connected through a voltage divider to ground, to give the correct voltage at the grids. The voltage drop is necessary because the control voltage is sent from the studio at 150 volts to overcome the possible effects of transient voltages on the line, such as might arise from cross-talk from dialing circuits, and from earth currents. Capacitor C_{13} provides an audio path around the bleeder circuits, completing the circuit of the line through the transformer.

The Mixer-Phase Inverter

The second stage, a 6SN7, is connected in what appears to be a dual-channel amplifier. The secret of this stage lies solely in the omission of the cathode by-pass capacitor. In so doing, any signal voltage is left on the cathode, and appears in both sections. Thus any signal in either section is coupled to the other section, mixing one with the other. However, the section opposite to that

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into which the signal is fed operates like a cathode driven, inverted amplifier. *Figure* 2 shows the respective phase relationships on the various elements. Since there is no electron migration through the grid resistor of the section with no signal impressed, the effective resistance is zero, and this grid remains at ground for both d.c. and audio. When a negative signal is placed on the grid of section 1, a negative voltage appears on the cathode, and a positive voltage appears on the plate. However, with the grid of section 2 at ground, a negative potential on the cathode will produce a negative voltage on the plate. Thus it is easy to see that the two plates of the 6SN7 are out of phase, inversion having taken place. As has been shown previously, any signal on either grid will produce output in both sections, so this stage has effectively accomplished both phase inversion and mixing electronically.

As will be seen by further analysis, diregarding the bias, the total potential difference between the grid and cathode of the second section can be equal only to the rise and fall of the first-section cathode. Obviously, this will not be as great as the difference in the first section where it will be equal to the rise and fall of the cathode plus the impressed signal. Hence there will be some unbalance. In a low-gain stage such as this it will be negligible, and it can be disregarded largely in a class A stage. However, in the interests of fidelity, the cathode bypass was omitted in the output stage, and by the same action just described, the balance is restored.

Miscellaneous Circuit Details

Not much need be said about the power supply. It is completely standard, and uses receiver parts. That does not hold true, however, for the preamplifier stages. A number of the resistors are rather critical, and should be as close as possible to the value shown. While the values shown for C_3 and C_7 are those indicated by the original designer, some trouble has been found with a slight time delay when operating the controls rapidly. As a result, there may be as much as half a second delay when the controls are turned, and the circuit jumps into action with a resultant "thump." It is not therefore suited to instantaneous changes of gain. To correct this condition, smaller capacitors might be substituted for the values indicated for C_3 and C_7. While very little decoupling is indicated, the first stages are fed from a decoupling resistor, R_{31}, in the power supply filter system. Inasmuch as the other two stages are out of phase with each other, and the voltage is fed in at a neutral point, decoupling these two stages should be unnecessary. A connection must be provided for an external ground which is very essential to operation of the remote control circuits. This ground should be some form of solid earth ground, such as a water pipe, or electrical conduit. With more modern wiring, it is often possible to pick up a good ground by securing a wire under the mounting screw holding the plate on a light switch or convenience outlet. While it is not necessary that the ground be of zero resistance, it should be constant so that the gain will not vary during operation. Therefore it is necessary to have solid connections throughout.

Notes on Construction

An ordinary 5 × 10 × 4 in. covered amplifier chassis was used. The bottom plate helps eliminate hum pickup from external sources. The original model was intended for use with high impedance mikes, so no input transformers have been shown. To provide for their possible future use, the power transformer was of the completely cased, shielded type, and was mounted under the chassis, at one end. This put it as far as possible from the mounting of any intended transformers, and also away from the input grids of the 6L7's. Observing this precaution, no trouble was experienced from magnetic hum. There is also the added feature of power-supply hum reduction by virtue of the connection of the preamplifiers through the mixer-phase inverter stage. Any hum in the plates of the preamplifiers will be fed into opposite sides of the mixer in phase and thus cancel in the output. If much local operation is contemplated, it may be desirable to install a VU meter and a headset jack for monitoring. Care must be taken not to let the d.c. flow through either the meter or the jack, which should be insulated from the chassis to prevent shorting out the control voltage on one side of the line.

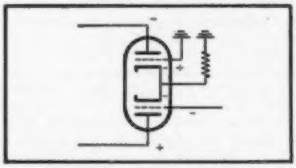


Fig. 2. Diagram of phasing of tube elements of mixer-phase inverter stage.

Operating Suggestions

Power for control of the amplifier can be obtained from any well filtered d.c. source of around 150 volts. With the bleeder resistors shown (R_{27}, R_{28}, R_{29}, and R_{30}), the drain will be about 5 ma., so even a "B" battery would last for almost its shelf life. This current value is not critical, and can be made even lower if necessary. If a different voltage is to be used, the divider resistors R_{27}, R_{28}, R_{29}, and R_{30} should be adjusted to give 30 volts at the tap when the maximum voltage is applied to the line. The controlling pots can be mounted as permanent additions to the control board, or assembled into a portable unit which may also contain the terminating coil, and even the power supply if desired. Line polarity should be observed if it is necessary to know definitely which fader controls a given mike. This should be determined in the original setup, and the operators should be familiarized with the program routine so that the proper mike will be open when necessary. Power supply polarity should be arranged so that the line is negative, and the ground return is positive. A log- or audio-taper control will give greater linearity of control action. *Figure* 3 shows a suggested studio control arrangement.

Two of these units have been in use by the author for about five years at various locations, and they have given excellent service in every case. Their most frequent use has been where two remotes are consecutive, both requiring more than one mike, but the operator was unable to travel between them in time. This system, in effect, gives the studio man a "long arm" by which he can twist the faders at the remote location until the regular remote operator can appear on the scene. In smaller stations, better production can ordinarily be had without the need for a man at the site. With the proper setup, and a short familiarization, anyone should be able to obtain perfect results, and with care in operation, every show can go off without any failures or errors. Actually, better mixing should be achieved, because there is not the distraction of local noise and no direct hearing of the program material to confuse the operator.

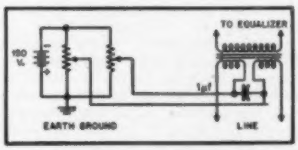


Fig. 3. Suggested connections of studio gain control unit.

Parts List

C_1, C_2	.05 µf, 600 v.
C_3, C_7	0.25 µf, 600 v. (see text)
C_4, C_8	8 µf, 150 v. electrolytic
C_6, C_9	.05 µf, 600 v.
$C_5, C_{10}, C_{11}, C_{12}$	.025 µf, 600 v.
C_{13}	1.0 µf, 600 v.
C_{14}	40 µf, 450 v. electrolytic
C_{15}, C_{16}	20-20 µf, 450 v. electrolytic
L_1	15 H, 75 ma.
R_1, R_{10}	1.2 meg, ½ watt
R_2, R_{11}	0.82 meg, ½ watt
R_3, R_{12}	47,000 ohms, ½ watt
R_4, R_{13}	33,000 ohms, 1 watt
R_5, R_{14}	1000 ohms, ½ watt
R_6, R_{15}	0.25 meg pot, audio taper with SPDT switch
R_7, R_{16}	33,000 ohms, 1 watt
R_8, R_{17}	0.15 meg, 1 watt
R_9, R_{18}	0.33 meg, 1 watt
$R_{19}, R_{20}, R_{24}, R_{25}$	0.47 meg, ½ watt
R_{21}, R_{26}	850 ohms, 1 watt
R_{22}, R_{23}	10,000 ohms, 1 watt
R_{27}, R_{29}	24,000 ohms, 1 watt
R_{28}, R_{30}	6200 ohms, ½ watt
R_{31}	12,500 ohms, 2 watt
T_1	Plate-to-line, 15,000/500-600, split secondary
T_2	300-0-300 v. at 75 ma; 6.3 v. at 2 amps; 5 v. at 2 amps.

An AES Paper Presented March 31, 1951

The Measurement of Audio Volume

H. A. CHINN*

A comprehensive discussion of the problems involved and the instruments employed to indicate program level and sine-wave tones in broadcast and recording circuits.

IN ALTERNATING CURRENT THEORY there are three related values of a sine wave by which its magnitude may be expressed. These are the average value, the r.m.s. (or effective) value, and the peak (or crest) value. Certain fundamental electrical measuring devices provide means for determining these values. Complex, non-sinusoidal periodic waves also have the same three readily measured values. As a rule, the problem under consideration determines whether the average, the r.m.s., or the peak value of the wave is of primary importance.

Concept of Audio Volume

In the field of communication engineering, waves which are both very complex and non-periodic are encountered. When an attempt is made to measure such waves in terms of average, r.m.s., or peak values, it is found that the results can no longer be expressed in simple numerical terms since these quantities are not constant but variable with time. Moreover, the values appear to be affected by the characterictics of the measuring instrument and the technique of measurement. The communications engineer, however, is vitally concerned with the magnitude of these non-sinusoidal, non-periodic waves since he must design and operate systems in which they are amplified by vacuum tubes, transmitted over wire circuits, modulated on carriers, and otherwise handled as required by the various communication services. He needs a practical method of measuring and expressing these magnitudes in simple numerical fashion.

This need may be better appreciated by considering a typical example—the communication systems employed for broadcasting. These are often very complicated networks spread over large geographical areas. A typical network may include 20,000 miles of wire line and hundreds of amplifiers situated both along the line and in the 100 to 200 connected broadcasting stations. Every 15 minutes during the day the component parts of such a system may be shifted and connected together in different combinations in order to provide for new points of origin of the programs, for the addition of new broadcasting stations, and for the removal of others from the network. In whatever combination the parts of the system may be assembled, it is necessary that the amplitude of the transmitted program waves —at all times and at all parts of the system—remain within the limits which the system can handle without impairment from overloading or from noise. To accomplish this, some convenient method of measuring the amplitude of program waves is needed.

These and similar considerations led to the conception of a fourth electrical quantity, known as "volume", whereby the magnitude of waves encountered in electrical communications, such as speech or program waves, may be readily expressed. This quantity is a purely empirical value, created to meet a practical need. *It is not definable by means of a precise mathematical formula in terms of any of the familiar electrical units of power, voltages or current.* Volume is simply the indication of an instrument known as a volume indicator, which has specified dynamic and other characteristics and which is calibrated and read in a prescribed manner. Because of the rapidly changing character of the program wave, *the dynamic characteristics* of the instrument are fully as important as the value of sine-wave power used for instrument calibration. The readings of volume have been customarily expressed in terms of decibels with respect to some volume level chosen as the "reference" level.

Volume Indicator Applications

Volume indicators are used extensively to indicate the correct transmission level for speech and program waves in audio systems employing amplifiers, program-actuated automatic devices, program wire circuits, modulators, sound recorders and reproducers, or wherever the transmission of speech and program waves are involved. In this capacity volume indicators serve as a guide to the avoidance of overloading. Equally important, they serve as a means of indicating approximately the comparative loudness with which various elements of a complete program will be heard when finally converted to sound.

Volume indicators are also used for checking transmission gains and losses in program networks and audio systems by simultaneous measurements at a number of points on particular peaks or impulses of the program wave which is being transmitted. They are also used for sine-wave transmission measurements on audio systems and circuits.

In spite of its importance and its extensive and universal use, the volume indicator is probably the least understood of all audio measuring instruments. For this reason the standard volume indicator, its reference level, its method of calibration and the teminology used for volume measurements is covered in detail in the following paragraphs.

Peak vs. r.m.s. Volume Indicators

In the study that led to a standard volume indicator[1] the decision had to be made as to whether the standard volume indicator should be of the r.m.s. or of the peak-reading type. These two types of instrument represent two schools of thought. The peak-reading instrument is favored for general use by many European engineers and is specified by the F.C.C. for use as modulation monitors in this country. The r.m.s. type has however, been employed in this country on broadcast program networks and for general telephone use. In view of the importance of the decision and the difference of opinion that has existed, the basis on which the choice was made is discussed below in some detail.

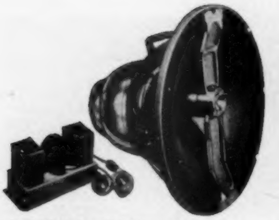
In accord with common practice, the terms "r.m.s." and "peak-reading" are used rather loosely herein. The essential features of an r.m.s. instrument are a rectifier or detector and a d.c. milliammeter. The movement of the latter is not especially fast, generally requiring tenths of a second to reach substantially full-scale deflection. Obviously, if a wave of sufficiently low frequency is applied, say one whose frequency is one or two cps, the instrument can follow it and the true peaks of the wave will be indicated. But when much higher frequency waves are applied, such as the complex speech or program waves, the instrument is too slow to indicate the instantaneous peaks, rather, it averages or integrates whole syllables or words. As shown by tests and practical experience, it is of secondary importance whether the detector actually has an r.m.s. (or square law) characteristic, or has a linear or some intermediate characteristic.

[*Continued on page 28*]

* *Columbia Broadcasting System, 485 Madison Ave., New York 22, N. Y.*

Responsibility for the contents of this paper rests upon the author, and statements contained herein are not binding upon the Audio Engineering Society.

[1] Chinn, Gannett and Morris; *Proc. I.R.E.*, Vol. 28, No. 1, p. 1, Jan. 1940.



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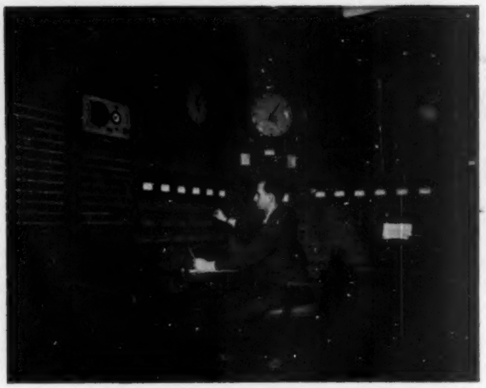
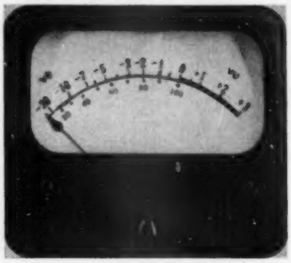


Fig. 1. An installation of twelve standard volume indicators, on an equal number of outgoing program circuits in the CBS shortwave master control room.

A peak-reading instrument capable of truly indicating the sharpest peaks which occur in a high-quality program wave would have to respond to impulses lasting only a very small fraction of a millisecond. Cathode-ray oscilloscopes or gas-tube trigger circuits are capable of doing this and consequently, might be used as a peak-reading volume indicator. However, the so-called peak-reading volume indicators used in practice, designed to give a visual indication on an instrument, are far from having the above speed although they are much faster than the r.m.s. instruments. They generally respond to impulses whose duration is measurable in hundredths or thousandths of a second. As a result they truly indicate the peaks of waves whose frequencies do not exceed say, 50 to 100 cps. They are similar to the r.m.s. instruments in that they are not fast enough to indicate the instantaneous peaks of speech or program waves but tend to average or integrate a number of peaks of the wave.

A feature of the usual peak reading instrument which is superficially impressive, but from which the analytical standpoint is of secondary importance, is that it is usually given a dynamic characteristic of rapid response coupled with very slow decay. This is usually acomplished by a circuit wherein a capacitor is charged through a full-wave vacuum-tube rectifier, the rates of charge and discharge being determined by resistances. A d.c. amplifier and instrument indicate the charge on the capacitor. The advantage of making the discharge rate of the capacitor very slow is that the indicating instrument itself need not then be particularly fast and, moreover, the ease of reading it is greatly increased.

From the above analysis it is seen that the r.m.s. and the peak-reading instruments are essentially similar and differ principally in degree. Both indicate peaks whose durations exceed some value peculiar to the instrument and both average or integrate over a number of peaks the shorter, more rapid peaks encountered in speech or program waves. Either may have an r.m.s. or square-law detector, or one of some intermediate characteristic. The important difference between the two types lies in the speed of response as measured by the length of impulses to which they will fully respond, or what is the same thing, in the time over which the complex wave is integrated.



Courtesy General Electric Co.

Fig. 2. The "A" type standard volume indicator scale emphasizes the VU markings and has an inconspicuous voltage scale. This type of scale is commonly used for transmission measuring sets.

Peak Checking

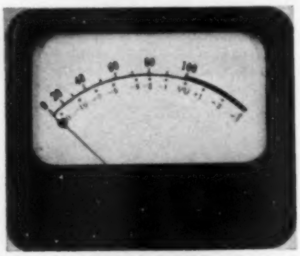
An important use of volume indicators is that of checking the transmission losses or gains along an audio system or a program network by measurements made on the program material being transmitted. The circuits which make up broadcasting networks, for instance, are in continuous use for many hours each day and during that period are switched together in as many combinations as called for by the operating schedules. It is seldom possible to free a circuit for sine-wave transmission measurements. Therefore to check the transmission conditions during service hours, it is the custom to take simultaneous readings at two or more points in the program networks on particular impulses of whatever program wave is being transmitted and to coordinate these readings by means of telephone communication. On such readings, the r.m.s. type of instrument is far superior to the peak-reading type. This is because phase distortion and slight nonlinearity in the program circuits (the results of which are too small to be detectable by ear) change the wave shape of the program peaks sufficiently to cause serious errors in the indications of the peak-reading instrument but have no noticeable effect on the r.m.s. instruments.

The effect of a long program circuit on the indication of the peak instrument is partly due to the cumulative effects of the slight nonlinearity in the many vacuum-tube amplifiers and loading coils in the circuit, and partly to phase changes which alter the wave front and amplitude of the peaks. It might be thought that phase changes which destroy some peaks would tend to create others. However, a Fourier analysis of a sharp peak will show that an exact phase relationship must exist between all of the frequency components. The probability that phase shift in a line will chance to cause all of the many frequency components of a complex wave to align themselves in the relationship necessary to create a peak where none existed before, is very slight, indeed infinitesimal compared to the probability of the occurrence of a peak in the original wave.

Data on peak checking showed such a marked advantage for the r.m.s. type as compared with the peak instrument, that it was decided to employ the r.m.s. type of instrument. Other considerations included the possibility of employing copper-oxide rectifiers and thereby eliminating vacuum tubes with their attendant need of power supply; an advantage not shared by peak-reading instruments. Thus, the r.m.s. instrument has advantages of comparative low cost, ruggedness, and freedom from the need of power supply, and can, moreover, be readily made in portable forms when desired.

Dynamic and Electrical Characteristics

It will be appreciated from the above discussion that for a volume indicator to be truly standard, both its dynamic and electrical characteristics must be controlled and specified so that different instruments will indicate alike on the [*Continued on page 36*]



Courtesy General Electric Co.

Fig. 3. The "B" type standard volume indicator scale emphasizes the percentage scale. This scale is used extensively for program transmission applications.

EDWARD TATNALL CANBY*

THE LP RECORD sailed past its third anniversary this last spring and now moves into its fourth year of active existence. They said it would take ten years, but in three the Microgroove Revolution is over, except for minor clean-ups. The Battle of the Speeds is a memory, with both new speeds settled in their rightful areas (much as this department suggested when 45 appeared, you will note); all is sweetness and light, RCA blissfully advertising 45's and selling LP's, Columbia happily advertising LP's and very quietly and on tiptoe, making lots and lots of 45's. Tape has completed its own occupation of the record industry, too. Small-company LP continues to expand, but that development has reached its full tide. All in all, after one of the fastest periods of change in record history, we've reached a relatively flat plateau at last.

Definitely a good time for a look around. And having taken it, I'm in the mood for some potshots at several aspects of the up-to-date recording business in which I've been displaying enthusiastic interest and approval up to this point. Sometimes things go a bit too far in a good direction.

Repertory

For the longest time I've been an enthusiast for unusual, out-of-the-way music and an objector to the standard repertory of concert works that get played over and over again. (Not so much an objection to them *per se* as an objection to the repetition.) There isn't the slightest doubt as far as I'm concerned that about nine tenths of the listenable good music—maybe 99/100—has been until very recently in the total-neglect category, dust-gathering in the corners of a thousand libraries. People like what they hear often; they hear what they like; which establishes a circular system that feeds busily upon itself, ingrowing, since the more a piece is heard the more people want to hear it. The singing ad people know that, and for that matter so do the concert managers. (Virgil Thomson of the *New York Herald-Tribune* wrote a killing series of articles last spring on the forced limitations of repertory put upon the big touring artists. Unbelievable.) It pays to keep overhead low—musical overhead too. But it's bad for music and in the long run bad for people.

Long before LP, I was plumping away for the out-of-the-way, for that huge amount of music that we could enjoy if we'd only just play it. Records after all, are the very antithesis of concerts in this respect. It doesn't really matter in the slightest to *you*, a record owner, whether a piece is played a lot or a little in public. You own it, you can play it as much or as little as *you* want. Statistics as to how many other people have heard it, how often it has been done, can't possibly affect you and your own ear; only your own phonograph can do that. Music that may be utterly familiar to you, down through the years, can be utterly unknown to most people. Nothing but a "keep up with the Joneses" attitude can make you feel that you must know the music the Joneses know, or else!

I had a series of radio programs around 1944 or so that harped on this theme—and I had to hustle to find recordings to play on it. There was very little to be had in the way of "unknown music." When, after the war, several small companies appeared, making 78-r.p.m. records of unusual music, out of the beaten path, I rejoiced. Vox, Musicraft, Concert Hall Society, Disc, Alco, were the pioneers here, and the field was almost theirs. Only the foreign imports, at high prices, the execrable 78 jobs put out by a few struggling minor outfits for special purposes, and a trickle from the Biggies, like Victor's pre-war "Connoisseur's Corner," helped out.

When LP came and a year later the tremendous expansion of small-company LP boomed in, I was delighted and said so. Suddenly, unusual music was economically possible—and it could be turned out high fidelity too. Wonderful. Hundreds of odd items appeared where there was one before. A prodigious wealth of new music, overwhelming me with a fulfillment of my own argument that would have been utterly inconceivable a few short years earlier. Talk about out-of-the-way repertory—it was with us in a deluge!

Even so, I'm still basically enthusiastic, though new recordings which would have had me gasping with excitement back awhile, tend to stir me to just another weary sigh now. I've long since been operating at about 198 per cent capacity. I still prefer to review, to discuss and to recommend the non-repertory works—an endless field of operation, after all, since the established conventional concert repertory is really very small.

But I must, at this point, join up at last with the opposite camp to some extent. In the recent flood I regretfully admit that I detect something more than enthusiasm for the unusual. Granted that unusual music is legitimate for a small outfit, since it's safe, won't be instantly duplicated and smothered by some larger company out for the kill. Granted that out-of-the-way music is all that's left to feed LP, even with dozens of repeats on the old warhorses. The record business is too big for the standard repertory now. Not enough music to go around. These things I don't mind.

But what is bad is the increasing tendency to sloppy choice—anything as long as it's hitherto unrecorded. Here is my warning and objection. Potshot number One. True, some companies are still quite above reproach. But others are not, decidedly. There's lots of good music left, but unimportant stuff has been issued by the ton—just because it's new on disc. Along with poor choice of music there is a most regrettable tendency to poor or mediocre performance. Tape is too easy. Anybody can record anything. Yes—I agree that small companies doing ambitious works cannot afford the long rehearsal that's possible with big-company operations. Even so, many smaller outfits have managed to issue well played, carefully processed records; the half-baked performances (and sloppy recording too) found on some other discs is more of a painful contrast. And it's not always the small companies that are guilty.

And so I reverse my engines for awhile and suggest that we'd better look to our repertories. Fewer records, please, and done with more care. No question about it, tape and LP have allowed quality standards to drop dangerously low. I'm hopefully sure that the company which puts out a few items, carefully chosen and lovingly prepared, will prosper more in the end than the rush-job outfit that plops stacks of LP's on the market so fast one can scarcely keep up with the announcements.

I was, and still am, an enthusiast for the things one can do with tape. It's a terrific

[*Continued on page 32*]

* *279 W. 4th St., New York 14, N. Y.*

medium. Editing, erasing, repeating-until-the-perfect-take are features of immense value.

Yet tape editing, I'm beginning to feel these days, is getting entirely too big for its boots. I'm having a definite conservative fit at the moment. The good old days. One can do miracles with tape in the way of achieving a good or excellent finished result via the patching of many takes—but I feel strongly that this method should never get out of hand—it should be in all cases regarded as a kind of emergency super-repair trick. Like Penicillin. It will cure many tragic mistakes that in the old days would have meant a complete new performance, beginning to end-of-side. It gives us the cream of numerous tries. But just as you can't live with permanent Penicillin to finish off all the bugs in you for life, so you can't take the patchwork symphony or concerto as a final work of art.

That's what is happening now. Tape editing has become so well entrenched that recording people no longer *expect* to record a piece of music as written, in one piece. Moving picture technique, cut and fill, slice and patch, is taken for granted. Miracles come forth, but the danger, artistically, is very great. And for no simpler reason than that music was never written to be put together thusly, and isn't written that way now.

A musical piece is a unity in the playing and should be in the recording—barring emergencies. Tape technique is there for the meeting of emergencies. *Not* for the creation of synthetic, patched-together artificially one-piece performances. Potshot number Two.

Potshot Three is just an opener. I expect to have more to say on the subject, indirectly, later on.

The "classical" record business began in America. When it went symphonic, the focus moved pretty much away. In the late 20's and in the 30's most of the great recordings were made in Europe, re-pressed in this country or imported in finished shellac. Only Victor kept the home fires burning, notably with the Philadelphia and New York Philharmonic orchestras. Record collectors knew the London, Berlin, Vienna Philharmonics better than their own American orchestras.

The approach of War turned the tide back—RCA had tried out the Minneapolis; Columbia suddenly started to learn how to record on its own in the U.S.A., with some pretty sad results for awhile. Remember how strange it seemed to see American city names, American artists, on the familiar red and blue classical labels? But it was good, and by 1948 or so American classical music was doing fine, both technically and musically.

Then came LP and the small company expansion. And the portable tape machine. Perhaps it is possible to look upon the tremendous influx of European-recorded music since that time as an unmixed blessing. I don't do so.

Certainly we have had not only a superb choice of music and a lot of top performances, not to mention the healthy (for us) introduction of European culture, European styles of performance, European names, to broaden our own perspective. It is good to listen every day to music played in France, Belgium, England, Austria, Germany, Italy, even Russia and Czechoslovakia, and to note the differences in ways of doing things; with high-fidelity recording, we are immeasurably lucky to be able almost to sit right in, a few feet away from a performance taking place in Prague, or Milan, or Vienna, and feel ourselves, after numer-

ous playings, so at home as to be almost a Czech or an Italian or a Viennese for the moment. Like a rewarding trip abroad. Good for our own musical taste.

But good for our own music—I mean, home-played? No. The reason we have European-made recordings is, alas, entirely removed from the cultural sphere! Our musicians cost too much. European musicians are absurdly cheap, easily available.

I have no judgments to make now. It's a complex situation. Clearly, we cannot lower our standards of living to compete directly in music with the European musician. He is poorly paid, but then, prices are not as high, perhaps, for him in his own country. The rate of exchange, making dollars worth so much more than in the past, puts a horribly artificial barrier between normal interchange of musical labor between countries. We can hardly expect the Musician's Union here to cut recording rates so that direct competition with European recordings can exist—it's just plain impossible, unless our government wants to subsidize music as do many foreign governments. A minimum wage must be held to, somehow, and it will never be low enough to meet foreign competition.

Keep out foreign music, then? A possible answer, like foreign beef. But with that I could never go along, however much some musicians would like the idea. An artificial barrier like that could do nothing but dire harm to music—for our music is unassailably tied to Europe's at this point by a thousand close artistic unities.

The key to the situation undoubtedly lies in the dog-and-tail effect of popular and big-time music, films, shows, radio, and TV, versus the microscopic tail of classical music, which does *not* wag the dog. Musician's rates, Union-determined, are geared to big-time stuff. They are high because there's big money in big-time. That money, you may be sure, would never reach the Union musician unless he had fought tooth and nail for it these many years. He doesn't get too much of it now. Not compared to what others get out of it. But classical music?

Classical music rates are no different than any other, speaking generally. And classical music, symphonic and the like, is therefore pretty much limited to what amounts to big-time operation—though there's nary a symphony or opera that doesn't lose money hand over fist every year. Big-time classical can get big-time sponsorship—sometimes—on the air; big record companies can afford to record it and pay for it through sales of records. But no small company can touch the field, in the U.S. Big-time rates apply anywhere and everywhere; there has been no attempt to set lower rates for small-scale, small-production efforts in music. Thus only a few major outfits do any classical recording here. Only a few musicians out of thousands are regularly employed in it. They are well paid—but they are few.

Whereas in Europe, classical recordings of every sort are being taped voluminously these days. Perhaps they are underpaid for; but business is obviously booming on all fronts. And at our own musicians' expense. European musicians are paid less on all counts, but more of them seem to be at work, more regularly. They're working overtime for us and they don't even get to hear their own product; the tapes are sent directly over here and almost never appear as records in Europe itself.

All of which leaves this operator, at least, with an uneasy feeling. Something is wrong. There must be a better adjustment possible than is now in force. It's hard to

believe that our Union musician is so tied up in big-time operations that he just doesn't care a hoot about the piffling little classical side line. It's no longer a piffling side line but a considerable business, and all-European. If he does care, then it seems to me he's being unrealistic and to his own detriment. One can't help feeling that there must be a way to get our own musician in on the classical LP field on a larger scale without hurting his basic rights, and to his own greater benefit; some compromise that would divert some of the flood of LP music to home production.

But how?

SPANISH SAUCE

Falla, Dances from The Three Cornered Hat; Palau, March Burlesque, Hommage à Debussy: Rodrigo, Homenaje a la Temperancia; Iturbi, Seguidillas; Chavarri, Interior from the Valenciannos.
Valencia Symphony, Iturbi.
RCA Victor LP LM 1138

A Program of Spanish Songs.
Conchita Supervia; Frank Marshall, pf.
Decca LP DL 7510

The RCA record with the long title looked interesting. It is, but only mildly so. Here's music from Spain by a number of unheard composers and we seldom get anything but the standard items from that country. Judging from these, however, Spain isn't getting along too fast in its musical evolution; most of this unfamiliar music is a semi-recasting of mcre or less familiar Spanish-Romantic idioms, with a bit of dissonance—a very small bit—here and there. Just above the salon level, but pleasant listening. The music recorded in England, is issued by RCA, at least in the LP version, with that curious limpness of highs and thinness of bass noticed often in the past.

Conchita Supervia, the superb singer-dancer-actress of days long past, briefly steps out of legend in this LP reissue or recordings dating originally from the early 30's. Those who saw and heard her will be thrilled in memory—but newcomers will deduce that she depended much on the eye and on her sense of drama, complete with seductive Spanish costuming; these mere recordings, minus the eye's aid, display a rather nervous and uneven voice, if a powerful and very Spanish one. The piano playing, unexpectedly, is outstanding—Frank Marshall. The ancient recording adequately restored. (Side 1: Seven Spanish Songs by Falla; side 2: Tonadillas, seven songs by Grenados.)

Try these on your hi-fi outfit

(Note: With the present flood of new LP's continuing unabated it's not hard to find examples of top-quality recording. Good records come a dime a dozen, so to speak—but even so, the number of slightly or definitely substandard offerings is quite appalling, as any owner of high-quality reproducing equipment knows, nor is it easy to determine in advance via the usual record-shop players! A condensed listing is continued here, for those who want to be reasonably sure that their records match their equipment in quality. Good musical performance is assumed, as is good microphoning for the type of music. Large numbers of LP's have been by-passed, though entirely listenable musically, the following being first-class and no less, according to my ear.

Big-Orchestra Stuff

Hanson, Piano Concerto in G. Firkusny, Eastm.-Roch.
Grieg, Holberg Suite.
Col. ML 4403

Smetana, The Moldau; From Bohemia's Fields

& Groves. N. Y. Philh. Szell.
Col. ML 2177

*Bruckner, Symphony #6. Vienna Philh. Swoboda.
Westm. WL 55-56 (2)

Tchaikowsky, Romeo & Juliet; Francesca da Rimini. N. Y. Philh. Stokowski.
Col. ML 4381

Sibelius, Finlandia; Chabrier, Espana. Goteborg Symph., Berlin Philh.
Cap. H-8138

Hindemith, Symphony in E flat. Janssen Symph.
Col. ML 4387

*Prokofieff, Love for Three Oranges Suite; Lt. Kije Suite. Fr. Nat. Orch. Desormiere.
Cap. P-8149

Dvorak, Symphony #2. Berlin Philh., Schrader.
Urania URLP 7015

*Janacek, Suite for Strings; Taras Bulba. Winterthur, Vienna Symph., Swoboda.
Westm. WL 5071

*Brahms, Piano Concerto #2. Ney; Berlin Philh. Max Fiedler.
Decca DL 9536

Tchaikowsky, Symphony #5. Phila. Orch., Ormandy.
Col. ML 4400

Schubert, Symphony #4. Vienna Symph., Sacher.
Program EXLP 704

Strauss, Don Juan; Till Eulenspiegel. Amst. Concertgebouw, Karajan; Berlin Philh. Fricsay.
Decca DL 9529

Mozart, Piano Concertos #14, #22. Badura-Skoda; Vienna Symph. Sternberg.
Oceanic OCS 22

*Dukas, Sorcerer's Apprentice; Gretry, Cephale et Pocris Suite. INR Symph. Andre.
Cap. L-8135

Bruckner, Symphony #4. Vienna Symph. Klemperer.
Vox PL 6930

Haydn, Symphonies #52, #56. Vienna Opera Orch., Symphony, Heiller.
Haydn Soc. HSLP 1039

Rimsky-Korsakoff, Piano Concerto; Scriabin, Piano Concerto. Badura-Skoda, Vienna Symph. Swoboda.
Westm. WL 5068

Schubert, Symphony #6. Austr. Symph., Woss.
Remington RLP 149

Brahms, Symphony #4. Berlin Philh., de Sabata.
Decca DL 9536

* Outstanding sound quality.
* Old (disc) recording, reissued. Excellent quality.

Profs Practice What They Teach

Nineteen prominent professors—chosen from leading engineering colleges—are augmenting their academic knowledge with practical know-how this summer by working side-by-side with Westinghouse engineers and workmen in the company's Industrial Experience Program. Principal objective of the program is to assist colleges in the development of a more competent engineering school graduate, and one who can more easily make the transition from campus to industry. The program moves toward its objective by bringing professors face-to-face with the engineering needs and problems of American industry.

Professors participating in the program are paid a regular salary and are given assignments in their particular fields of study.

AUDIO VOLUME MEASUREMENT

[*from page 28*]

rapidly varying speech and program waves. In deciding upon the dynamic characteristics, an important factor included in the consideration was the ease of reading the instrument and the lack of eye strain in observing it for long periods.

For ease of reading and minimum of eye fatigue, the movement should not be too fast. As a result of observations under service conditions, and other tests, the requirement was adopted that the sudden application of a 1000-cps sine wave of such amplitude as to give a steady deflection at the scale point where the instrument is to be read, shall cause the pointer to read 99 per cent of the final deflection in 0.3 second.

It was also noted that on speech and program waves, instruments which were critically damped or slightly overdamped had a more "jittery" action than instruments slightly underdamped. Consequently the strain of reading the former type is greater than for the latter. A theoretical study of the problem verified the validity of this subjective observation. The requirement was therefore adopted that the standard volume indicator movement shall be slightly less than critically damped, so that the pointer will overswing not less than 1 per cent nor more than 1.5 per cent when the sine wave mentioned in the preceding paragraph is applied.

The question of whether the rectifier, which is a part of the standard volume indicator, should be half-wave or full-wave needs little discussion. As is well known, many program waves (particularly speech) show a marked lack of symmetry. Obviously, if an instrument is to give the same indication, no matter which way it is poled, a balanced full-wave rectifier is required.

Throughout this discussion, the term "r.m.s." has been used loosely to describe the general type of instrument under consideration. The equation that relates the instrument coil current to the potential applied to the volume indicator is:

$$i = ke^p$$

where i = instantaneous coil current.
e = instantaneous potential.
k = a constant.

The exponent p in the above equation is 1.2 for the standard volume indicator. Therefore its characteristics are intermediate between a linear ($p = 1$) and a square-law or "root-mean-square" ($p = 2$) characteristic.

In many applications *the rectifier law is just as important as the other electrical and dynamic characteristics* of the standard volume indicator. Unfortunately, there is a tendency to overlook this fact in many instances and to simply specify that the indicating instrument of some particular piece of measuring equipment "shall have dynamic characteristics identical to that of the standard volume indicator."

Instrument Scale

Among the more important features to be considered in the development of a volume indicator is the design of its scale. In broadcasting studios, volume indicators are under observation almost continuously by the control operators. Consequently, the ease and accuracy of reading, and the degree of eye strain are of major importance.

It is evident that the instrument scale should be easy to read in order that the peak reached by the needle under the impetus of a given impulse may be accurately determined. The instrument scale, therefore, should be as large as practical since, in the case of the broadcast and recording applications, attention is often divided between the action in the studio and the volume indicator.

Volume level indicators are used (a) as an aid to tailoring the wide dynamic range of an original performance to that of the associated transmission medium and (b) for locating the upper part of the dynamic range just within the overload point of an equipment during its normal operation. For the first of these uses, a scale having a wide decibel range is preferable. For the latter purpose, a scale length of 10 db is usually adequate. Since a given instrument may be used for both applications neither too large nor too small a range is desirable in volume level indicators for the above purposes. A usable scale length covering 20 db appears to be a satisfactory compromise.

Both VU markings[2] and markings proportional to voltage are incorporated in the new instrument scale. The need for the former is obvious, but the philosophy which lead to the inclusion of the latter may require some explanation.

It is evident, assuming a linear system, that the voltage scale is directly proportional to percentage modulation of radio transmitter or recording system upon which the program is finally impressed. If the system is adjusted for complete modulation for a deflection to the 100-per cent mark, then subsequent indications show the degree of modulation under actual operating conditions. In the interests of best operation, it may be desirable, of course, to adjust the system for somewhat less than complete modulaton when the 100 per cent indication is reached.

In any event, the indications on the voltage scale always show the *percentage utilization of the channel.* This is a decided advantage because everyone concerned (both technical and non-technical personnel) has a clear conception of a percentage indication. Furthermore, since the scale does not extend beyond the 100 per cent mark (except in the form of a red warning band) and since it is impossible to obtain more than 100 per cent utilization of the facilities, there is less incentive on the part of non-technical people connected with program origination, to request "an extra-loud effect" on special occasions.

Actually, two scales, each containing both VU and voltage markings, have been standardized. One of these known as the type A scale, *Fig.* 2, emphasizes the VU markings and has an inconspicuous voltage scale. The second, known as the type B, *Fig.* 3, reverses the emphasis on the two scales. This arrangement permits the installation of the instrument which emphasizes the scale that is most important to the user, while retaining the alternate scale for correlation purposes.

Ever mindful of the possibility of eye fatigue even the color of the scale card has been standardized. It is a light orange-yellow, which seems to be a satisfactory compromise between high contrast and reduced eye-strain. This choice was based upon the preference of a large group of skilled observers and upon the reports of certain societies for the improvement of vision. The use of matte-finished instrument cases having fairly high reflection coefficients, such as light gray, is also desirable for ease of vision.

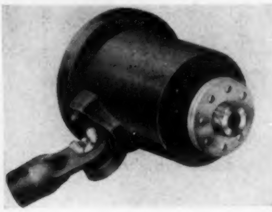
Finally in studio applications the scale must be properly illuminated so that the relative light intensity on the face of the instrument is comparable to that on the sound stage. Unless this condition prevails, the eye may have difficulty in accommodating itself with sufficient rapidity to the changes in illumination as the operator glances back and forth from the studio to the volume-indicator instrument.

(To be concluded)

[2] Terminology is explained in a following section.

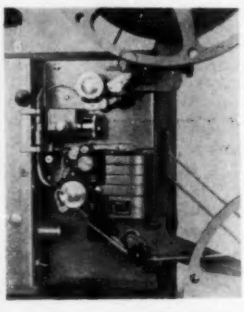
NEW PRODUCTS

• **Explosion-Proof Speakers.** New Racon driver models XP-1 and XP-2 are Underwriters listed for use in situations contaminated by explosive gasses and dusts respectively. Both units are designed for



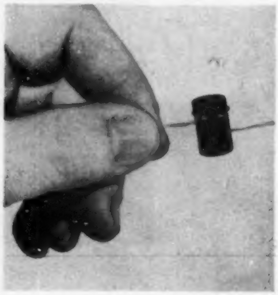
announcing and paging applications, and have a continuous power rating of 30 watts. Voice coils are wound of aluminum wire, and terminals are welded to dispense with the corrosive effects of solder. Housings are made of heavy cast aluminum and are tapped for standard ½-in. rigid conduit. Complete information will be supplied by Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y.

• **Magnetic Recorder-Projector.** Direct recording of commentary or musical background on processed 16-mm film is achieved for the first time with the new Model 400 projector recently demonstrated by RCA at the annual trade show of the National Audio Visual Association in Chicago. The unit makes use of 16-mm film on one edge of which is a one-tenth-inch-wide strip of magnetic oxide. Recording, erase and playback are accomplished in a manner identical with that used in conventional tape recorders. In addition to magnetic reproduction, the Model 400 will also playback standard 16-mm film with



optical sound track. Especially significant is the fact that the equipment affords the advantages of magnetic recording and reproduction on 16-mm film where costs are restricted by the need for only a limited number of prints. Also of interest is the ability of the 400 to permit revision or replacement of sound on single prints without the cost and time required for laboratory processing. RCA Victor Division of Radio Corporation of America, Camden, N. J.

• **Voltage-Surge Suppressor.** Life of unprotected contacts used in relays, contactors, and similar electromagnetic devices, can be increased by at least 30 times through use of the voltage-surge suppressor recently announced by Federal Telecommunication Laboratories, Inc., Nutley, N. J. Developed in connection with Federal's research on selenium rectifiers, the suppressor is similar in protection characteristics to the varistor. However, the selenium unit draws measurably less power when the circuit is energized. The difference in the current requirements of the selenium suppressor and the varistor represents an appreciable savings where a large number of relays are involved. For most telephone relays, the new Fed-

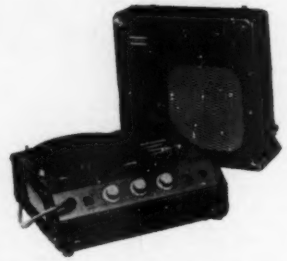


eral suppressor is small enough to be hung directly across the terminals. Suppressors for heavier devices are correspondingly larger. Tests of the suppressor have run in excess of fifty million operations without failure.

• **Inconspicuous Microphone.** Latest entry in the field of miniature microphones, designed to give audiences a clear, unobstructed view of performers, is the new crystal Model DK-1, manufactured by The

Astatic Corporation, Conneaut, Ohio. Finished in brushed chrome to reduce light reflection, the DK-1 is a non-directional high impedance unit with crystal element coated to resist the effects of high humidity. Output level is – 55 db. Available with or without off-on switch.

• **Transcription Player.** Advertising agencies, schools, radio stations, and other users of portable playback equipment will find many uses for the Newcomb combination record player-p.a. system. Containing a 5-watt straight a.c. amplifier, 10-in. Alnico speaker, and a 3-speed turntable which accommodates records of all sizes, the Model R-16 offers great flexibility together with exceptional audio performance. Speaker section of case is removable

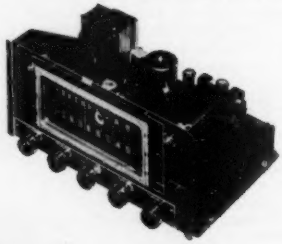


and is equipped with a 25-ft. extension cable. Panel mounted microphone input jack and mixing volume control make the R-16 a practical p.a. system. Overall size is 14 x 15 x 8½ in., and weight is 22 lbs. Manufactured by Newcomb Audio Products Co., 6824 Lexington Ave., Hollywood, Calif.

• **Branching Networks.** Broadcast stations, motion-picture sound studios, laboratories, and recording studios will find many uses for the new Daven Series 1130 multi-

ple networks. Among their many functions are the equalization of incoming signal levels, the combining of two or more incoming lines into a single outgoing line, or the dividing of one incoming line into two or more outgoing lines. The networks are available in either balanced "H" or unbalanced "T" circuits. Resistors are precision wire-wound with ±2 per cent accuracy. Maximum pad level is + 24 VU. As many as ten inputs or outputs may be obtained. For most values frequency range is from zero to 50 kc. Full technical information will be supplied upon request to The Daven Company, 191 Central Ave., Newark, N. J.

• **High-Quality FM-AM Tuner.** Remarkably low AM detector distortion and an unusually effective 10-kc-interference fil-



ter are features of the 14-tube circuit in the new Model SR-51 FM-AM tuner recently introduced by The Sargent-Rayment Company, 212 Ninth St., Oakland 7, Calif. Designed for custom installation, the SR-51 includes a unique two-tube tone-control system which varies the 600-cycle crossover frequency only 4 db when bass and treble controls are swung from maximum to minimum. The AM section consists of a pre-tuned r.f. stage and a broad-band stage of i.f. terminating in a detector with distortion limited to 0.48 per cent at 400 cps with 100 per cent modulation. A null-type filter has zero attenuation at 9 kc and 47 db at 10 kc, thus effectively limiting adjoining-station interference. Wide-range FM section includes AFC and has sensitivity of 5 microvolts. Descriptive literature and engineering data will be supplied on request.

• **Sound Level Meter.** Improved low-frequency response and refinements in mechanical design are inherent in the new Model 410-B Sound Level Meter now being produced by Herman Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass. Sound level range of the 410-B is from 34

to 140 db above the standard ASA reference level of 0.0002 dynes/sq. cm. The instrument is both compact and rugged due to use of subminiature tubes and unique miniaturization techniques on which patents are pending. Power supply is self-contained and consists of standard hearing-aid batteries which have an operating life of 50 hours. Extension cables and vibration measuring equipment are available as accessories. Technical bulletin will be mailed without charge.

• **Ultrasound Intensity Meter.** A new instrument for the measurement of ultrasonic sound intensity is the Sonotest, recently introduced by the Radiological Cor-

poration of America, 18 Lackawanna Plaza, Orange, N. J. Produced by the Siemens-Reiniger organization, the Sonotest indicates transmitted ultrasonic power on a scale calibrated directly in watts. The Sonotest can be used for under-water measurements and will give indications in any desired position. Range is from 0 to 60 watts.

New Danish Playback Machine

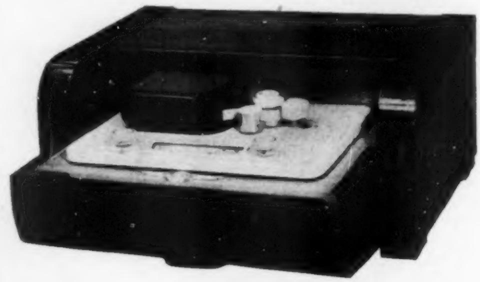
SVEND ANKER-RASMUSSEN*

Laterally-modulated groove recorded in endless plastic tape provides 60-minute playing time.

SINCE THE ADOPTION of electro-acoustic recording technique some 25 years ago, there has been no radical departure from conventional disc recording methods. Electrically recorded gramophone discs made high-fidelity reproduction possible but still had the drawback of limited playing time. The U. S. answer to this problem was the advent of LP records, but this was not a complete solution. The possibility of 15 to 20 minutes uninterrupted recording on one side still left a large number of music works which had to be "chopped up" with the resulting headaches to recording engineers and producers. There also remained the weak spot of rotating-disc recordings: the relative speed of the needle to the groove decreases as the spiral approaches the center.

Magnetic tape recording does away with limitation of recording length as far as a great majority of music is concerned, but high-fidelity reproduction requires rather costly apparatus, and magnetic tape recordings are not easily adaptable to mass production. Yet this type of recording procedure was undoubtedly the inspiration to Dr. Daniel, a German sound engineer and researcher. His new invention, the Tefifon, constituted the technical sensation of two recent large-scale radio exhibitions. It was first introduced to the public simultaneously at Copenhagen, Denmark, and Dusseldorf, Germany.

The accompanying illustration does more to describe the new device than many words could. The recording medium is an endless polyvinyl-chloride tape with 56 parallel sound tracks spaced at the ordinary rate of four tracks per millimeter. The groove oscillations are reproduced by a crystal cartridge pickup mounted in the turret, seen at the extreme right of the playback chassis, which may be positioned to play back any one of the tracks, or automatically operated to reproduce the tracks successively. Its position is indicated by a pointer along a slide-rule dial. According to tape length and the number of grooves, the Tefifon may be used for playing times of 24, 48, or 60 minutes, but if the tape is twisted half a turn it may be inscribed on both sides with a maximum time of 90 minutes.



The Tefifon tape recorder.

A synchronous motor draws the tape past the pickup, which is designed to cut off sharply around 7500 cps, at a speed of 54.6 cm/sec, which corresponds to the linear speed of an LP record at a radius of approximately 6 in. The tape is housed in an enclosed cassette resembling a book, within which it passes over a number of spring-loaded rollers which serve to keep it taut against the guiding rollers in front of the pickup. The ends of the tape are "welded" together by radio-frequency heating and tapered so as to make a completely flush joint. The tape books are smaller, lighter, easier to use, and much better protected against breakage and mechanical molestation than conventional disc records. The groove speed of the pickup point is constant throughout the whole recording, and the hardness of the plastic tape in conjunction with almost complete freedom from grain ensure high quality of reproduction. Needle noise is reduced to a minimum.

While no details of the Tefifon record-

[*Continued on page 43*]

* *Deputy Editor,* Radio Ekko, *Copenhagen, Denmark.*

TECHNICANA

Tuning Fork Filter

A method of extracting weak signals from random noise through the use of a tuning fork as a resonant filter element is the subject of an article in *J. Acous. Soc. Am.*, November 1950, by Karl N. Wulfsberg. An experimental tuning fork filter for 1,000 cps was made by fabricating the fork from cold rolled steel and driving it with high-quality coils.

The fork was mounted on small metal washers and had the tines drilled and threaded for adjusting screws. The driving and pickup coils were assembled on laminated silicon steel cores with headphone magnets as the source of flux. The driving coil was fed from a pentode amplifier and the insertion loss measured in the usual way. The Q of the system was obtained by measuring the time constant. Since a Q of the order of 10,000 with an insertion loss of the magnitude of 20 db is easily obtained, it is obvious that the filter is suitable for separating weak signals from random noise.

The band width of such a system is about one cycle for the fork described. Its temperature coefficient is about 100 parts per million per degree centigrade and the frequency variation with input level is about 20 parts per million per volt in the range measured. It should also be noted that the Q of the system is readily adjustable, and that frequencies far removed from resonance are highly attenuated. Frequency variation for tuning the filter is small, however, but may be had by adjusting the tine screws.

Adjustable Reverberation

In an article by Paavo Arni in the May 1950 *J. Acous. Soc. Am.*, the construction of a broadcasting studio having an adjustable reverberation time is described. Earlier work to devise studios having variable reverberation characteristics led to the design, in Copenhagen, Denmark, of a studio in which the reverberation time at 1,000 cps is constant and the slope of the reverberation curve versus frequency is varied.

In the present design carried out at Helsinki in the studios of the Finnish Broadcasting Company the reverberation time may be varied from 0.72 to 0.9 sec. at 100 cps, from 0.72 to 1.2 sec. at 1,000 cps, and from 0.8 to 1.0 sec. at 8,000 cps. The average value of the change in the middle audio range is of the order of 0.4 seconds, and the average slope is horizontal.

To accomplish this change, hinged panels of absorptive material are hung on the hard plaster walls of the studio in a pleasing symmetrical, but acoustically satisfactory pattern. When the units are closed half of the wall space is hard plaster and the remainder is the hard two-inch thick glossy painted surface on the back of the absorbing unit. When the absorbing units are open they expose the surface of a thin sheet of perforated plywood in back of which is a one-inch layer of rock wool and another sheet of thin plywood. This covers an air space backed by the two-inch thick cover. The back sheet of plywood and the air space form an absorbent vibrating system for low-frequency energy, while the rock-wool balances the absorption for the high frequencies.

It should be noted that the even response which obtained at the low frequencies is attributed to polycylindrical diffusers in the studio. Variations within the limits of reverberation times specified are easily obtained by opening the absorption units only part way. To facilitate the change from one condition to the other an operating rod has been provided.

The success of the design in the studio described has led to the inclusion of similar units in three new halls for broadcast pickup now in the design stages in Finland.

Positive Feedback

Thomas Roddam, writing in *Wireless World*, July 1950, describes the benefits and pitfalls attendant to the use of positive feedback in audio amplifiers.

Using the well known relations for feedback the distortion in an amplifier is found to be reduced by the factor $1/A\beta$ where A is the forward gain of the amplifier and β is the fraction of the output signal fed back. The above factor is of course an ap-

proximation which holds within a few per cent when $A\beta$ is large.

If positive feedback is now introduced into the amplifier thereby raising A by 6 db, and β remains the same the gain of the amplifier remains the same, but the value of $A\beta$ has doubled. That is, the gain of the amplifier with feedback is approximately $1/\beta$ so that A may be increased considerably without changing the external gain of the amplifier. However, since $A\beta$ has doubled and this appears in the denominator of our distortion reduction factor, we find that the distortion has been halved. This is a reduction of 6 db. Not only does the distortion drop when positive feedback is added, but the frequency response is also improved. There is, however, a steep price to be paid for this reduction in distortion and improvement in response, and that is the care with which the overall design of the feedback amplifier must now be carried out. This is brought about by the increase in phase shift in any stage in which positive feedback is employed, which may remove all phase and gain margins originally designed into the circuit.

Some of the trouble introduced by positive feedback may be obviated by using it over a limited band of frequencies. This may be done through the selection of an appropriate network for the introduction of the positive feedback signal. *Figure* 1

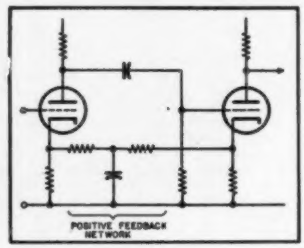


Fig. 1

illustrates a method of introducing positive feedback in the first two stages of an amplifier, provided the negative feedback signal is not also applied to the first cathode.

Modern Disc Recording

A survey article on new trends in disc recording by P. Gilotaux appears in *L'Onde Electrique* for July 1950.

Modern methods of preparing stampers are reviewed briefly, followed by a discussion of the bandwidth required for high-fidelity reproduction. The general considerations of wavelength, velocity, amplitude, and acceleration in relation to groove diameter and disc speed, are covered, as well as the sources of surface noise and the effect of stylus burnish. The final section of the paper is an uncompromising evaluation of microgroove recording at both popular speeds.

Ultrasonics

A general treatment of the fundamentals of ultrasonics is presented in *Electronic Engineering* for January 1951 in an article by A. E. Crawford. This work does not, however, present the derivations of the various equations for velocity and amplitude. Following a discussion of longitudinal, shear, and surface waves is a brief consideration of the reflection of waves at a boundary.

The remainder of the article is devoted

to a survey of the various acoustical-mechanical and electro-acoustical generators and their ranges and adjustment.

Distortion Measurement

H. F. Olson and D. F. Pennie are the authors of an article in the *RCA Review* describing an automatic analyzer for the measurement and recording of harmonic distortion. By adding a device which automatically supresses the fundamental frequency to a standard automatic frequency response curve tracer, it is possible to obtain the curve of the level of the distortion in decibels below the level of the fundamental plus distortion. This may then be converted into per cent r.m.s. harmonic distortion.

The heart of this system is the automatic means for suppressing the fundamental. The criterion of dependability was set for this device and led to the selection of mechanically switched filters having a steeply sloping high-pass characteristic. The ones used are 600-ohm, single-ended, *m*-derived, toroidal networks, each being padded out with resistance pads so that all the filter sections have the same insertion loss. Each of these filters is designed to work for half an octave, thus requiring fourteen of them to cover the range 40 to 15,000 cps. The point at which each of these high-pass filters is switched into the line is determined by the output of one of fourteen sharply selective bridged-T networks. These networks are tuned to the point at which the filters should be switched, and as the null frequency of the bridged-T is passed, a switching relay is closed and this in turn operates a stepping switch which does the actual switching of the high-pass filters.

The system is particularly adapted for loudspeaker measurements where continuous plots are needed to obtain information of real value.

LC Oscillator Stability

Tesla Technical Reports for December 1949 carries a thorough study of the oscillator stability problem under the title "LC oscillators and their frequency stability."

The frequency stability of an LC oscillator is controlled not only by the designed LC elements, but also by the variations in interelectrode capacitance with varying tube potentials, and variations in Q and transconductance.

These considerations lead to the design criterion that the plate and grid of the oscillator tube should be connected to points on the tuned circuit that are at low impedances as are consistent with the maintenance of oscillation. Oscillators of high stability have been developed which in general meet the conditions imposed, and include those of Gouriet, Clapp, Lampkin, and Seiler.

In analyzing these oscillators it is determined that the Clapp oscillator is very simple, but must be limited to a tuning range of 1:1.2 for any one set of component values. The circuits of Seiler and Lampkin have a tuning range of about 1:1.8, and all three circuits are exceptionally stable.

In order to extend the tuning range, O. Landini in Italy, and Tesla National Corporation in Czechoslovakia developed a circuit of high stability with a tuning range of 1:2.5. It combines the principles of Seilers circuit and that of the cathode follower oscillator.

A complete analysis of the circuit is given and the computation of the stability at various frequencies is carried out.

DANISH PLAYBACK MACHINE

[*from page 40*]

ing and tape-manufacturing processes are available as yet, the inventor's representative claims that recording costs are comparatively low, even though relatively few copies are required. Tefifon transcriptions can be offered at attractive prices, but the main stress will be laid on commercial exploitation of the new recording technique. Contracts are said to have already been made with a number of artists and conductors for recording of commercial tapes for mass-production as soon as a substantial number of Tefifon players have been put on the market. The "tape-gramophone" may be used in connection with any ordinary broadcast receiver.

While not yet confirmed by backers of the new system, it is expected that a turntable and an ordinary pickup may be added to the Tefifon player to bridge the gap between disc and the new player.

LETTERS

[*from page 12*]

Transient response is determined by two performance factors—overshoot and rise time—if we may apply pulse-circuit theory. A speaker that is said to have excellent transient response on the basis that it develops no overshoot may achieve this by excessively heavy friction damping or excessive compliance, which in turn results in high-frequency cutoff and a slow rise time. Thus a highly damped speaker may not have any noticeable overshoot, but it cannot faithfully reproduce the steep wavefronts of percussive signals and will reproduce a square-wave as a distorted trapezoid.

If we speed up the rise time, we have excessive overshoot; if we reduce the ringing, we lose out on response speed. Truly a design dilemma. Using pulse-circuit theory, it can be shown that series-shunt juggling of the three mechanical circuit parameters and by holding them down to the lowest practical limits can give a wide bandwidth with a fairly linear phase shift at the high-frequency end. By holding down the frictional damping to the lowest possible level and allowing a few per cent of controlled overshoot, a fast rise time and wide bandwidth is achieved at the expense of a bit of transient distortion. On this basis, a single-cone, wide-band, low-distortion speaker appears to be out of the question.

Ted Powell,
42 Nassau Road,
Great Neck, New York

MUSIC and MASS PRODUCTION

[*from page 23*]

are not enthusiastic about their jobs and often change employers to attain a degree of variety in equally monotonous jobs; they constantly watch the clock in order to rush away from their machines for rest periods or for departure from the plant; they are careless, causing accidents and delays that may slow down or halt production; they are nervous and restless; the quality of their work is poor; and they tend to absent themselves from their work.

With the ever increasing mechanization of modern industry fewer and fewer jobs requiring the slightest amount of mental activity are available. To make jobs interesting, music has often been applied successfully, and results similar to those obtained at Lily-Tulip are to be found in many parts of the national economy.

From the material presented so far, several conclusions may be drawn:

1. Music is of use only in monotonous jobs such as in repetitious assembly work, which is the basis of interchangeable manufacture (mass production).
2. Music is beneficial only where the intelligence level of the workers does not deem it to be a distraction.

Whenever music is used certain things

happen in the individual that affect his work. Extensive work on the subject by Diserens[5] reveals.

1. Music tends to reduce or to delay fatigue and consequently increases muscular endurance.

2. Music has no definite effect on accuracy or precision of movement, if the movement is not adapted to the rhythm of the work.

3. Music speeds up such voluntary activities as typewriting and handwriting. It also accelerates respiration.

4. Music increases the extent of muscular reflexes employed in writing, drawing, etc.

5. Music seems to have a tendency to reduce the extent of illusions by acting as a distracting factor.

Burris-Meyer[6] conducted a series of experiments demonstrating the efficacy of music as an aid to production by the application of the principles mentioned above. His results are shown in *Fig.* 1. Note that music impedes the effects of fatigue for most of the working period, but does not delay it indefinitely.

Up to this point the effect of music upon individuals only has been discussed. Modern industry depends upon teamwork and group action for its tremendous productive output. It is here that the phenomenon of empathy—defined psychologically as the principle of kineaesthetic appreciation—becomes of importance. An example will illustrate the principle. The author attended a concert during the summer at Lewisohn Stadium in New York City when Brahms' First Symphony was performed. Out in the open, the ordinary restraints of the concert hall are not present and the audience expressed itself vocally when it has the emotional urge to do so. The beginning of the fourth movement is dramatic and somber; it rises to a highly emotional level and then becomes extremely lyrical. At this point the audience does feel bound by musical convention and "releases itself" by humming the main melody *en masse*. Music is seen, through the principle of empathy, as a means of bringing together in spirit a large group of people, provided they have the same taste in music.

The keynote of industrial music is variety and anticipation. ". . . expectation helps to create a favorable frame of mind. The thoughts of the workers, instead of being directed to long monotonous periods of drudgery, are diverted by anticipating the music."[7] When music is played in industry it is not used continuously because it would become a part of the surroundings and would have no effect upon production. It is played intermittently (see *Fig.* 1 for a typical schedule) and in that way helps

[5] Charles M. Diserens, *"The Influence of Music on Behaviour."* Princeton Univ. Press, 1926.

[6] Barbara E. Benson, *"Music and Sound Systems in Industry."* New York: McGraw-Hill, 1945.

[7] L. E. Broome, "Music while you work." *Indus. Welfare and Pers. Mgt.*, May–June, 1942.

to add variety to the working day. The worker waits for the music, speculates as to what will be played, and wonders how long it will continue. Some plants vary the music schedule to avoid what psychologists call the "butter-butter effect." When a word or act is repeated excessively the individual attaches no significance to the word or act after a short time. If music is repeated at the same time every day during the year it does not have the desired effect upon production that it should have and becomes a waste of time and money on the part of management.

The employee reactions mentioned in the first paragraph of this article are not the result of the application of only one factor to the production process, and it must be remembered that music is only one factor. Mayo[8] has shown that any change in working conditions that signifies to the worker that management has his interest at heart will increase production. Music is a welcome change in the work atmosphere that will remain for a long time and will help to bring beneficial results if not misused.

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[8] Elton Mayo, "*The Human Problems of an Industrial Civilization.*" New York: Macmillan, 1933.

BASS-REFLEX CABINET

[*from page 19*]

this equation, the air in the tunnel moves vigorously, while a high impedance is presented to the walls of the enclosure where the speaker is mounted. It will be noted that the characteristics of the speaker itself do not enter directly into the equations at all, although for optimum results, ω should be equal to 2π times the resonant frequency of the speaker used and R should be equal to the radius of a piston equivalent to the speaker cone.

Tunnel Location

Practical cabinets have the tunnel inside the cabinet structure and the volume of the tunnel, R^2L, should be added to the volume V to obtain the total volume. In this case:

$$V' = \pi R^2 \left(\frac{C^2}{\omega^2} \times \frac{1}{1.7R+L} + L\right) \quad (5)$$

The velocity of sound C is 1130 feet per second or 1.356×10^4 inches per second at a temperature of 20° C.

If all dimensions are expressed in inches

$$V' = \pi R^2 \left[\frac{1.84 \times 10^8}{\omega^2} \times \frac{1}{1.7R+L} + L\right] \quad (6)$$

and this expression has been plotted for various practical values of R, L and f. *Figure* 1 shows V', L, and f when R = 4 in. (10-in. speaker) and *Figs.* 2, 3, and 4 the corresponding values for 12-, 15-, and 18-in. speakers.

The volume occupied by the speaker itself is not included in V', and must be added to this factor or subtracted from the cabinet volume (if this is already fixed) to obtain V' before L and f are read off. There are two advantages in making L reasonably large: (1), the cabinet volume for a given resonant frequency becomes less as the tunnel is lengthened; and (2), as the mass of air in the tunnel is increased, the proportion of the mass reactance due to the outside air load on the vent is less, and the resonant frequency of the cabinet depends less on its position in the room. The assumption that the vent is radiating into semi-infinite space is usually incorrect and though the errors are not large the use of a long tunnel reduces them.

Tunnel Length

The length of the tunnel is limited by three factors. First, it must be short compared with a wavelength at the resonant frequency. Second, it must not approach the back wall of the cabinet so closely as to restrict the circulation of air (a distance equal to R is advisable). Third, after a certain point there is no advantage in increasing the tunnel length, since the decrease in unoccupied volume of the cabinet eventually causes the resonant frequency to rise again.

On differentiating equation *(6)* above,

it is determined that the cabinet has a minimum volume when:

$$L = \frac{C}{\omega} - 1.7R. \qquad (7)$$

This becomes:

$$L = \frac{2160}{f} - 1.7R$$

if dimensions are expressed in inches.

In general it will be possible to use this optimum tunnel length only for large speakers with a high resonant frequency. In other cases the tunnel will not be short compared with a wavelength. The dotted line on each set of curves represents the point at which the length of the tunnel reaches 1/12 of a wavelength and points on the main curves to the right of this line should not be used.

The tunnel need not, of course, be round. Any shape will do if its cross-sectional area is πR^2.

Figure 5 shows elevation, plan, and sectional views of a correct reflex cabinet of about 8,000 cu.ins., designed for use with the Goodmans Axiom 12-in. speaker which has a bass resonance of 55 cps. The cabinet is constructed of 1-in. plywood and lined with soft felt 1-in. thick. It combines good performance with an appearance that is not out of place in the home.

Conclusion

The foregoing data has been prepared bearing in mind the over-all results which may be expected from the completed instrument and it is not out of place to stress the importance of the choice of speaker. This choice is affected not a little by the need for a unit with good top response, in the absence of a separate high-frequency speaker. It is of interest to note that, in such a correctly arranged system, the response to transients is considerably improved as a result of the increase of mechanical resistance due to the correct air-loading of the speaker.

In this latter connection it should be borne in mind that the actual reproduction of transients from any loudspeaker is largely affected by the room in which it is placed, quite apart from any other consideration. That is to say, the room usually has a period of reverberation which is very much longer than that of the speaker so that, in practice, quite large deficiencies in this respect on the part of the speaker may be of small moment, in unfavorable situations.

AUDIO PATENTS

[*from page 4*]

dual rectifier tube used for muting. (The term is borrowed from Solovox nomenclature, where these tubes were used for the same purpose.) The waveform of *Fig.* 3 is symmetrical, which means it is composed entirely of odd harmonics; this makes it suitable to imitate woodwinds. When the muting rectifier chops off the positive peaks, even harmonics become apparent as well and the tone is better suited for string, brass, and other sounds. Normally the

mute tubes' cathodes are grounded by the arm of switch Sw_8 and the diodes produce the tone of *Fig. 4*. When Sw_8 is thrown to the dotted-line position, the positive voltage of the cathode-bias arrangement R_7–C_8 is applied through isolating resistor R_8 to the diode cathodes and conduction stops, so that the outputs of the dividers retain their original form as in *Fig. 3*. R_4 is an attenuating resistor to compensate for the volume rise when the diodes are disabled.

The stop switches are used to select whatever octave or octaves are desired for best artistic effect, and the combined tones are fed to a preamplifier tube. The plate

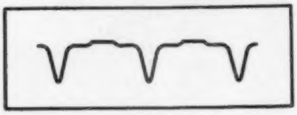

Fig. 4

load for the preamplifier is a series of *L–C* and *R–C* filters (just as in the Solovox) which can be switched in and out in combination to achieve different tone qualities. From here the tones go to the primary of an interstage transformer.

The transformer secondary feeds the grids of a pair of push-pull volume-control tubes. The arrangement, with the addition of a few small gimmicks, such as a provision for percussive as well as sustained volume envelopes, is the same in principle as in the Solovox and is thoroughly described in the patent.

Keying and volume control are dependent on the performer's voice volume. An additional lead from the output of the original sloping-response amplifier is fed to the grid of amplifier tube V_{18}, which supplies excitation for a full-wave rectifier. As the volume of the voice increases the rectifier puts out more positive voltage, which is fed to the centertap of the interstage transformer that supplies signal to the control stage grids. As the voltage becomes more positive, the output of the control stage increases; thus the performer's voice volume controls the output volume of the instrument.

This stage also controls keying. The control stage is normally at cutoff bias. As voltage from the rectifier comes to the grids, the cutoff bias is overcome. This is an especially good arrangement for reproducing normal musical attacks rather than depending on the attack characteristics of a fixed time-constant network.

The tube labelled *special* is used to create a percussive type of attack, and the switches not mentioned in and around the control stage are for more special effects.

Readers who would like more details on this circuit are referred to the patent, which, like all other U. S. patents, is available for 25 cents from the Commissioner of Patents, Washington 25, D. C. The circuits are fully explained, though no component values are given. To forestall any flood of mail to the Hammond company inquiring about circuit details or production plans, let us add that Mr. Hanert has already been queried and has replied—understandably—that it is Hammond policy not to disclose any future production plans or laboratory data relative to instruments yet to be produced commercially. Hammond holds a good many patents which it has not developed commercially. Whether or not this one will be it is impossible to say. But there is no doubt that it is the kind of new idea that will find a good home in many imaginative minds.

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PRESTO 90 — A three-channel recording and playback amplifier. Original cost $500.00, will sell for $250.00. Reco-Art, 1305 Market Street, Philadelphia, Pa.

PROFESSIONAL DIRECTORY

NEW LITERATURE

• **Shure Brothers, Inc.,** 225 W. Huron St., Chicago 10, Ill., is now issuing Replacement Manual No. 66 which lists over 1500 phonographs and radio-phono combinations, together with the Shure model number for each cartridge replacement. In addition to current models, listings go back as far as 1938 and include 123 manufacturers.

• **A-V Tape Libraries, Inc.,** 730 Fifth Ave., New York 19, N. Y., will mail free on request a copy of its initial catalog which lists selections available in the Company's library of music pre-recorded on magnetic tape. Along with titles are shown prices, which vary with playing speed and between single- and double-track recordings. A virtual must for all owners of tape equipment.

• **Magnecord Inc.,** 360 N. Michigan Ave., Chicago, Ill., has available a new illustrated catalog describing tape recording equipment for professional use, and introducing the firm's facilities for building equipment for unique applications. A special page is devoted to accessories such as special switches, adaptor panels, and spooling mechanisms. Booklet, together with a price sheet, will be mailed on request.

• **Centralab Division of Globe-Union Inc.,** 900 E. Keefe Ave., Milwaukee 1, Wis., is now issuing what is said to be the world's first Printed Electronic Circuit Replacement Guide for service engineers. Listed are 269 printed circuit plates as used by 69 manufacturers. Replacements are selected from a cross-reference chart which designates the Centralab catalog number for the original manufacturer's part number. Only 19 stock units are required to cover replacement requirements. Free copies available from Centralab distributors or by writing direct to above address.

• **Engineering Products Department, Radio Corporation of America,** Camden, N. J., has released a handsome booklet illustrating and describing the RCA Type RT-11A basic magnetic tape recorder, Type RT-12A console equipment, and custom-built recording and editing combinations for professional application. Accessories, such as remote-control units, metering panels, and vacuum equipment for cutting and splicing, are also covered. Because this equipment is entirely professional in nature, catalog distribution is limited to professional users and must be requested on company or station letterhead.

• **Standard Transformer Corporation,** 3594 Elston Ave., Chicago 18, Ill., is now distributing to the trade its mid-year catalog listing 441 Stancor transformers and related components. All listings contain electrical specifications, dimensions, weight, and list price. Illustrations show each mounting type in detail.

• **Sylvania Electric Products, Inc.,** Emporium, Pa., has recently completed a revised edition of the Sylvania Technical Manual in a new snap-open loose-leaf format. The manual now contains comprehensive technical data on 500 receiving tube types, including standard TV picture tubes. New data sheets on future tubes will be supplied to manual owners through the "Sylvania News." Included also in the manual are 84 pages of general information on vacuum tube operation. Priced at two dollars, the manual may be obtained from Sylvania distributors, or by remitting direct to the address shown above.

• **Keithley Instruments,** 1507 Warrensville Center Road, Cleveland 21, Ohio, has issued a 4-page bulletin illustrating and describing the Model 102 Phantom Repeater, a bridging amplifier for test instruments with unusually high impedance input. Titled "Quantitive Measurements on High Impedance Circuits," the bulletin includes, in addition to technical specifications, four excellent drawings which show the repeater in practical laboratory usage.

• **Superior Electric Co.,** Bristol, Conn., with its new Bulletin S351, has produced a catalog which adds distinct credit to the field of industrial publishing. Devoted to the company's line of Stabiline automatic voltage regulators, the bulletin is complete in every detail. Concisely drawn circuit diagrams and exceptionally fine illustrations combine with well-prepared text to make this a truly outstanding industrial catalog. May be obtained by writing the Company.

Heads Magnecord Engineering

Otto C. Bixler is the new director of engineering for Magnecord Inc., manufacturers of professional tape recorders. At one time associated with the electrical research products division of Western Electric, Bixler is credited with development of the first professional magnetic recording system sold to major motion picture studios.

Magnecord recently has established a new engineering development laboratory in Chicago, which will be under Bixler's direction.

Tape Library Pioneer

Credit for preparing and merchandising the first library of magnetic tape recordings for retail distribution to music lovers goes

to Charles E. Rynd, Chairman of the Board of Directors of A-V Tape Libraries, Inc.

In his position as head of A-V, Rynd brings to focus a broad experience in the audio field. Educated at M.I.T., he rose to the position of vice-president of the American Broadcasting Company, resigning to engage in his present activity.

O'Bryan Joins Sylvania

Appointment of Dr. Henry M. O'Bryan as manager of the company's Physics Laboratories was announced recently by Sylvania Electric Products Inc.

Dr. O'Bryan has served as instructor in physics at Johns Hopkins University, Harvard University, and at M.I.T.

Prior to joining Sylvania he was in an executive post with the Research and Development Board in Washington.

Industry Notes--

Operadio Manufacturing Company, St. Charles, Ill., has changed its name to **Dukane Corporation.** No change in ownership or personnel . . . **Federal Telephone and Radio Corporation** announces appointment of **Graybar Electric Company,** Inc., as national distributor of railroad communications and signalling equipment . . . **International Tel and Tel** has purchased **The Coolerator Company,** Duluth, Minn. and plans to add white goods to its present radio and TV lines . . . **J. A. Maurer, Inc.** has been awarded impressive U.S.A.F. contract for volume production of specialized camera for use in jet fighter aircraft . . .

Newark Electric Company, Chicago, campaigning to eliminate confusion resulting from change of name of **Newark Electric Co., Inc. of New York** to **Hudson Radio and Television Corporation** . . . **Dow Corning Corporation** amuses editors with cute letter informing "our customers, the water department, the telephone company, the paper boy, our ever-loving spouses, and the receptionist's boy friends" that the firm's new address is 600 Fifth Avenue, New York 20, N. Y. . . . **United Paramount Theatres, Inc.,** has appointed Dana W. Atchley, Jr. as coordinator of technical research—duties to include development of new techniques in theater TV field . . .

Sylvania Electric Products Inc. has placed Karel van Gessel in newly created post of coordinator of foreign manufacturing affiliates . . . **Stromberg-Carlson Company** has leased building at 1225 Clifford Ave., Rochester for enlargement of Sound Equipment Division . . . **True Recorder Company,** Detroit, has bought out the pre-recorded roller rink tape business of **Tape Recording Industries,** East Lansing, Mich. . . . New and larger headquarters offices now occupied by **National Association of Electrical Distributors** at 295 Madison Ave., New York City . . . **National Bureau of Standards** has named Nicholas E. Golovin as Assistant Director for Administration . . . **Westinghouse Electronic Tube Division** has named Harold G. Cheney as sales manager . . .

Industry People--

Jerome T. (Jiggs) Keeney, sales engineer of test equipment for 35 years, has retired from his spot with Simpson Electric Company to begin a career of fishing in Florida . . . **Bill Dubilier,** founder of Cornell-Dubilier Electric Corporation, in Europe for confirmation of decoration bestowed by French government in behalf of his efforts toward French recovery after World War II . . . **Dr. Arthur E. Middleton** placed in charge of research of dielectrics at Battelle Institute, Columbus, Ohio . . . **Irving Schawb,** formerly president of Art Radio Corporation, announces formation of Atlas Tel-Rad Parts, wholesale distribution firm . . .

Gordon Groth appointed executive vice-president of Erie Resistor Corporation . . . **Dr. C. J. Breitwieser** named executive of P. R. Mallory & Co., Inc. . . . **P. M. Pritchard,** formerly director of sales for Victor Electric Products Inc., appointed general sales manager for Parts Division of Sylvania . . . **John H. Cashman,** president of The Radio Craftsman, Inc., elected chairman of the Association of Electronic Parts and Equipment Manufacturers . . . **Roy Neusch,** director of Harvey Radio Company Sound Department, taking a month's leave at doctor's orders . . .

Frank Thornton, Jr., winner of the 1950 James H. McGraw award, retires from Westinghouse after 42 years of brilliant accomplishment . . . **Ovid Riso** elevated to vice-presidency of Philco International . . . **Dr. Ivan A. Getting,** gives up post as prof of electrical engineering at M.I.T. to become vice-president of Raytheon Manufacturing Company . . . **Jerry Kelly** taking up new duties with Telefex sales division of Audio & Video Products Corporation . . .

F. Sumner Hall, president of Audio Equipment Sales, rapidly becoming country's leading "impressario" in field of jacks and jack-strips . . . Engineers everywhere elated at appointment of **Frank Falknor** as vice-president of CBS—started as control operator at WBBM, Chicago . . . **"Moe" Morris** of Altec Lansing pinch hitting as technical expert while **Mel Sprinkle** is vacationing . . . **Irving Greene,** director of Sun Radio Sound Department, among mid-August fugitives from steaming-hot Manhattan . . . **Fred Thrower,** vice-president of ABC and prominent in audio field, back on the job after session with M.D.'s.

ADVERTISING INDEX

UTC was the largest supplier of transformer components in World War II. Present UTC production is on a similar basis. Illustrated below are a few of the thousand military types in UTC 1950 production.

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